PHOTOGRAPHIC

AND

OPTICAL ELECTRIC LAMPS.

BY

RANKIN KENNEDY.

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RANKIN KENNEDY,

Electrician and Engineer.

Author of "Electrical Distribution by Alternating Currents," and "The Scientific Study of Arc Lamps," &c.

A Treatise for Photographers, Photo-Electric Printers' Etchers and Engravers,

And including Apparatus for Copying Purposes for Engineers and Architects.

(59 ILLUSTRATIONS).

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PREFACE.

Electricity being now available to many Photographers, &c., and no work treating on this special subject being in existence, the author has ventured to put together brief descriptions of apparatus and lamps, in the hope that it will meet an oft-expressed want for a hand-book on the subject, placing descriptions and illustrations of the apparatus before the Photographer and Optician as it now stands.

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Photographic and Optical Electric Lamps.

BY RANKIN KENNEDY.

Chapter I.

THE INTRODUCTION of Electricity into towns and cities for electric lighting has placed within the reach of many photographers the use of electric light for photo-work, printing, enlarging, copying, and other purposes.

Electric light is also used by photo-etchers in photo-zincography, and in copying engineers' and architects' plans from tracings, &c. Yet there is no work treating specially of this class of apparatus which would be found useful as a guide to photographers, who, as a rule, are not fully acquainted with Electricity and Electric Lamps.

The author has had many years' experience with Electric Lamps as used in every kind of photographic work, and has originated many improvements in them. It is the object of this little work to show the various successful lamps and appliances, to describe in simple language the scientific principles upon which they are based, to point out fallacies in regard to their use and abuse, and to give a general idea of the working of each different kind of apparatus.

First, we may say a few words about the electricity supplied in towns, from which supply, photographers must draw their current. Unfortunately for electrical engineers and photographers, the supply of electricity differs greatly in different places, so that an apparatus made and found successful in one district may be an utter failure in another. Hence we must carefully note the kind of supply available for the apparatus before purchasing or constructing it.

Electric current supply is broadly divided into two kinds—continuous and alternating. The alternating supply is again divided

into about half-a-dozen different kinds, distinguished by what is known as their frequency. For instance, in the City of London we have an alternating current supplied at a frequency of 100 per second—it pulsates at the rate of 100 per second; in the Strand district and other places we have a supply at a frequency of 82 per second, and in the Holborn district we find another supply at 133 per second.

This diversity seems a most extraordinary thing, and it is certainly a reflection against the whole body of electrical engineers that such differences should have sprung into existence, causing, quite unnecessarily, great inconvenience, expense, and trouble. For there is no earthly reason why the frequency should not be the same all the world over if electrical engineers would only agree among themselves to use one common frequency. This could have been as easily done as it was easy to agree upon a standard Ohm, Volt, or Ampère unit. Unfortunately no agreement was made, and a number of supplies are laid on, in which the frequency cannot now be altered.

The photographer uses principally the arc-lamp, and this lamp hums disagreeably in unison with the pulsations of the alternating current. This often forms an objection to alternating currents for arc-lighting, especially in portraiture, where it is apt to disturb the sitter. The author invented an apparatus for the purpose of converting alternating into continuous current, and thereby enabling photographers to obtain the advantages of continuous currents, although they may have the misfortune to be situated in a district supplied by alternating currents.

The continuous current supplied in different places differs only in pressure. Electrical engineers have stupidly blundered in this respect also, for nothing could have been easier than to agree upon one common pressure of supply, and thereby have made it possible to work the same apparatus anywhere.

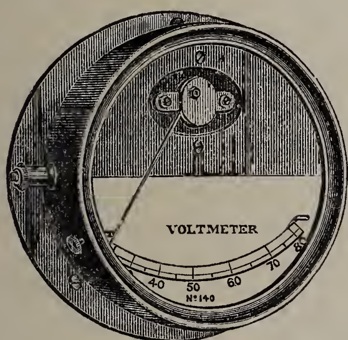
We find pressures supplied at 100, 105, 110, and 120 volts, and on three-wire systems we can get 200, 210, 220, and 240 volts supplied. It would have been infinitely better if all over the world 120 volts were the standard on the two-wire supply, and 240 on the three-wire.

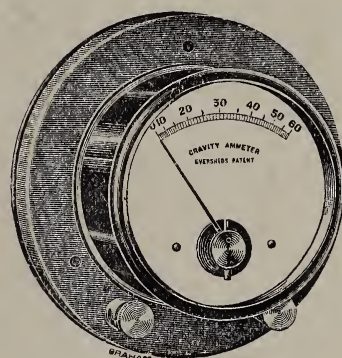
The mischief has been done, however, and is now beyond remedy in many cases. We are compelled, therefore, to enter into the consideration of various changes and devices required to adapt the apparatus to these differing supplies.

Whatever kind of current is supplied, it will come through a meter and be charged at an average price of about 6d. a unit. A unit of electricity is a quantity consumed by an ordinary 10-ampère arc-lamp in two hours' burning, or consumed in sixteen incandescent lamps, each of 16 candle-power, in one hour.

The volt is the unit of pressure of supply, and is indicated by a voltmeter. The ampère is the unit of current, and the volume of the current passing through a lamp is indicated by an ammeter.

The photographer who wishes to make the best use of his electric supply ought to know something of these instruments, so that we shall briefly refer to an example of each of Verity's make.





These instruments are represented in Figs. 1 and 2, and in any case an ammeter should be used to know what current is being absorbed in the lamps.

Both ammeter and voltmeter must be of the dead-beat kind, as an instrument in which the pointer swings about under any slight change is of no use.

Many instruments sold cannot be read on arc-lamp circuits, owing to this swinging about of the pointer, but plenty of good dead-beat instruments are to be had if insisted upon, costing from £3 to £4.

It is also important to get instruments for alternating circuits to be correct on the particular circuit on which they are to be used. An instrument all right on one may be all wrong on another circuit of alternating current, and in ordering instruments the frequency of the current should be stated if for alternating circuits.

RESISTANCES.

Resistances are required to regulate the volts on the lamp terminals, or pressure on the lamp. These resistances consist of spirals of German silver wire, strung on a frame, with a switch, as in Fig. 5, also of Verity's make. By moving the switch, more or less wire is put in the path of the current on its way to the lamps, and thereby the pressure of the current is reduced and the amount of current regulated.

Thus, if the supply is 110, and we want only 45 volts on the lamp with 50 ampères current, it is evident we must reduce the pressure by 65 volts. The resistance required to do this is easily found. The unit of resistance is called an *Ohm*, and the rule is to divide the pressure to be choked back (in this case 65 volts) by the current, which in this case is 50 ampères $= \frac{65}{50} = 1.3$ ohms = the resistance required.

Or suppose the pressure is 100 volts, and the lamp pressure 45 volts, and the current 25 ampères; here $100 - 45 = 55$ volts to be choked off, so that $\frac{55}{25} = 2{\cdot}2$ ohms.

In this way we can readily find what resistances are required to reduce the supply pressure to our requirements.

Fig. 4 is a diagram of a lamp, a resistance, and a supply, showing the various distributions of the pressure. The figure shows us the last case calculated: current 25 ampères, total pressure 100 volts, 45 volts in the lamp and 55 in the resistances.

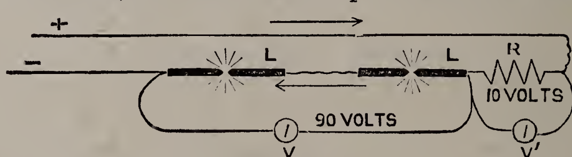


Fig. 3.

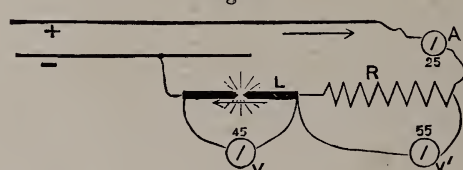


Fig. 4.

Now these resistances waste the electricity! You pay for the 100 volts pressure and use only 45. It is better, therefore, to use two lamps in series and get the full use of the pressure you pay for. Fig. 3 is a diagram explaining this double arrangement.

In Fig. 4, L is the lamp with the voltmeter V, joined

across to show the 45 volts pressure, R is a resistance of 2·2 ohms, with a voltmeter across which would show 55 volts being wasted, and A is an ammeter through which the current passes, and indicates, in this case, 25 ampères.

In Fig. 3, L L are two lamps connected in series, that is, the one current goes through both, and, as each takes 45 volts of pressure, the two will take 90 volts, as will be seen by the voltmeter V. In this case we have only to waste 10 volts on a 100 volt supply, so that for 25 ampères we want only $\frac{10}{25} = 0{\cdot}4$ ohm resistance for R.

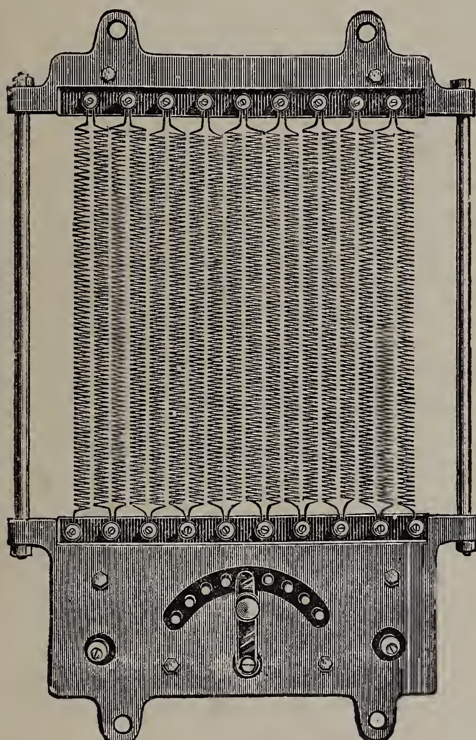


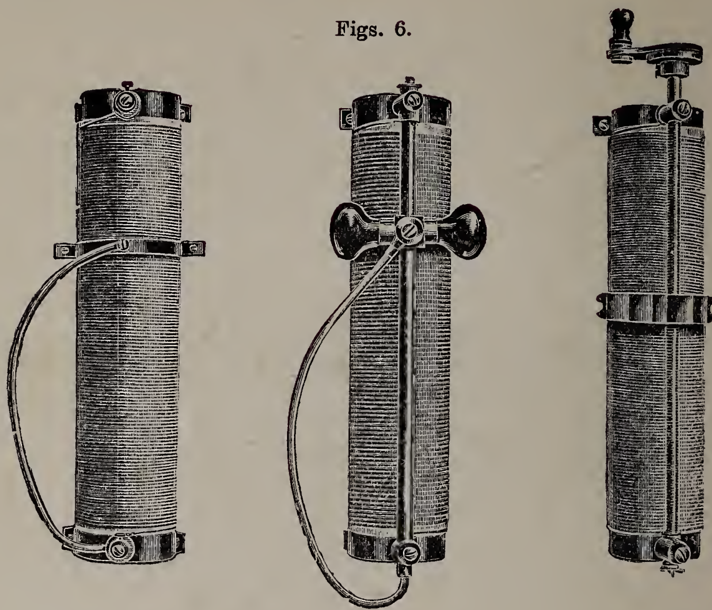
Fig. 5.

Fig. 5 is a construction for large resistances, where, for instance, 110 volts are to be reduced to 45 volts, and to carry a current of from 50 to 70 ampères.

For small resistances a spiral of wire, wound on an enamelled iron cylinder, as shown in Fig. 6, is used. A clamp, made of two half-circular hoops, is connected to one end, so that it may be

clamped on at any place to adjust the resistance to the desired amount.

Figs. 6.



No combustible material, on any account whatever, is to be allowed in the construction of resistances. Resistances waste the electric energy by turning it into heat; they must, therefore, of necessity work hot—sometimes nearly red-hot.

The wire used for resistances is sometimes platinoid. Tables of its size, weight, and resistance are easily obtained.

Messrs. Walter T. Glover and Co. have introduced a good material called manganin, a table of which is given. To use the table in selecting a wire for resistances, I have added a column of currents for which the wire is best suited. Thus No. 14 wire will carry from 15 to 20 ampères, so that, supposing we want 2 ohms resistance to carry 20 ampères, we should find in the table that a little over 1 lb. weight of this wire would give 2 ohms; we should find the length of this wire also, and could, therefore, prepare a cylinder or spirals to carry the quantity of wire.

TABLE OF MANGANIN.

BARE AND SILK LAPPED HIGH RESISTANCE MANGANIN WIRE.

Ampères at 3000 per square inch.	Size in Birmingh'm Wire Gauge.	Diameter.		Yards per lb. bare.	Ohms per lb. bare.	Ohms per Kilo.	Metres per Kilo.	Price per lb.		
		Inch.	Milli-metre.					Bare.	Single Silk covered.	Double Silk covered.
16	14	·083	2·1082	15·98466	1·95454576	4·3096725	32·1219	3/4	4/10	6/10
12	15	·072	1·8290	21·24179	3·4486336	7 605045	42·81984	3/5	4/10	6/10
9·5	16	·065	1·6510	26·0634	5·196424	11·45718	52·53696	3/6	4/10	6/10
7	17	·058	1·4732	32·734	8·196856	18·074385	65·991744	3/7	5/4	7/4
5	18	·049	1·2446	45·8633	16·090704	35·480655	92·45376	3/8	5/10	7/10
4	19	·032	1·0668	62·4253	29·810112	65·73105	125·8488	3/9	6/5	8/6
3	20	·035	·8890	89·892	61·813088	136·297665	181·21824	3/10	7/-	9/-
2·5	21	·032	·8130	107·5439	88·462288	195·05430	216·80064	3/11	7/3	9/4
1·75	22	·028	·7110	140·446	150·918656	332·7786	283·12704	4/1	7/11	10/5
1·5	23	·025	·6350	176·19	237·466336	523·62135	355·19904	4/3	8/5	10/11
1·2	24	·022	·5590	227·5345	395·97488	873·11385	458·70048	4/5	8/11	11/5
0·9	25	·020	5080	275·2587	579·74624	1278·34875	554·92416	4/7	9/3	12/2
0·6	26	·018	·4570	339·8278	883·62736	1948·40415	685·0368	4/8	9/6	12/11
0·5	27	·016	·4064	430·1466	1415·39824	312·09570	867·16224	5/1	10/3	13/6

Resistances must be used with all arc-lamps. A little resistance is necessary to enable them to feed well. One lamp requires, when carrying 20 or 25 ampères, 1 ohm for the 20 ampères, and 0·8 ohm with 25 ampères—in other words, 65 volts across both resistance and lamp, 20 in resistance and 45 in lamp.

Many lamps will work with less than a total voltage of 65, but not so well.

In alternating circuits resistances should be used only for that amount required to enable the lamps to be run steadily.

Lamps on alternating circuits should never be run in series but always run singly. That being so, the user should always either get his supply from the company at 50 volts, or provide himself with a transformer to reduce the pressure to 50 volts. This is important.

If this is not done, the 50-ampère Lamp would cost for current 2s. 6d. per hour, whereas if a transformer is used the cost will be only 1s. 3d., a saving which very soon pays off the £6 or £7 charged as the price of a suitable transformer.

Alternating lamps run well on a 50-volt circuit, as they take only 35 to 40 volts, leaving 10 to 15 volts for the regulating resistances.

REFLECTORS.

We may now consider the subject of reflectors. A very important thing is the reflector when large lights are employed; not only for economy but also for effect must the reflector be designed.

The most absurd ideas are prevalent on this subject, and reflectors of the most extraordinary shapes and forms are commonly in use. That any results at all can be got with them is due simply to the extravagant use of very high power arc-lights.

Some reflectors tested by the author produced fine portraits in less than one second's exposure with a light of 40-ampère power, while another form of reflector took two seconds with 70 ampères, the plates being the same quality in both cases.

First, then, as to shape of reflectors. We may point out that, as in all cases, dead-white surfaces are used; they are reflectors only—not mirrors. It is surface only we require, and it might be

a flat disc. In fact, the first exhibition of lighting from reflectors was at the Paris Electrical Exhibition, in 1880, the Art Gallery being then illuminated by Jaspar arc-lamps, in which the arc was concealed and the light thrown on to a large flat white disc from which it was reflected down upon the pictures, producing a fine daylight effect.

It is necessary to depart from the flat disc in order to catch all the rays, but even then we can still retain a very simple form, namely, a plane, conical shape like that shown in Fig. 9, a printing lamp of theauthor's for horizontal hanging, to be described later on.

The curved form, or umbrella-shape, is bad, expensive, and clumsy, and a test between a conical reflector and an umbrella-shape proves the fact that, while the cone reflected 80 per cent. of the arc-light, the umbrella reflected only 50 per cent. Both reflectors in this test were of the same diameter at the mouth, and such a difference was to be expected from theoretical reasons.

Size of reflectors is another important point. The general rule is simply thus—*the bigger the better.* What ridiculous little discs of reflectors we sometimes see on arc-lamps of 20 to 30-ampère power! Little things under 1 foot in diameter. They may act as screens to keep the light out of the user's eyes, but they never act as reflectors.

A 10-inch reflector is big enough for a gas jet or an incandescent lamp of 16 candle-power, and that is a size commonly used for such small lights, but when we come to collect and reflect lights of from 4,000 to 6,000 candle-power, 10 or 12 inches is absurd as a diameter for a reflector.

For photographing, where the light is to be thrown over a wide surface, the reflector must not be less than 4 feet 6 inches in diameter.

For copying photos or pictures by electric light or for copying plans and other work requiring the light on a smaller surface, more than one light is desirable, and a reflecting surface about 3 square feet at least for each light is required.

For photogravure or zinco-photo work, where only about 1 or 2 square feet is usually the surface to be lighted, a chalk reflector and bull's-eye lense is useful.

This arrangement is shown in Figure 8, A. The arc is formed in the focus of a parabolic reflector turned out of a lump of chalk, a cube about 5 or 6-inch sides, and bored to pass the carbon rods on two opposite sides. The lamp shown here is

hand-fed; the lens is built up of concentric rings in a brass frame, and throws a solid beam of light on to the print. The chalk makes an excellent reflector, and stands any amount of heat.

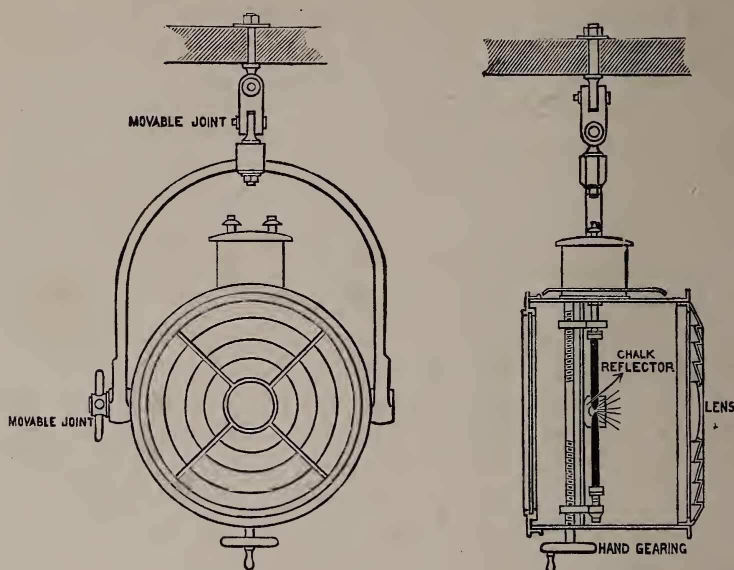


Fig. 8, A.

Coating of Reflectors.—The best coating for photograph reflectors is first a good grounding of white lead, then a few coats of pure zinc white mixed in thin, colourless lacquer. This is the best coating for the large reflectors where the direct light of the arc is screened.

But in many cases the direct light is desirable, such as for printing and copying. In these cases an iron reflector enamelled white inside, like the now common enamelled household utensils, is the best.

By a skilfully-designed reflector, carefully calculated in size for its work, a light of 30 ampères can do the work of a 50-ampère lamp with a small, badly-designed reflector, and the money lost in current in a year would most likely pay for a dozen proper reflectors.

Of course, such flimsy things as cotton, canvas, or silk umbrella-shaped reflectors are not considered at all here. The author, from experience, knows that only metallic reflectors are durable and safe. Nothing combustible should be tolerated in

photo-electric arc-lamp construction. Fires may be rare from arc-lamp causes, but that is no reason why we should make a fire possible.

A plane conical zinc reflector is substantial, incombustible, and serves the purpose both mechanically and, as a reflector, far better than the umbrella-shaped, fearful looking affairs used in some cases.

The photographer who has in use one of these extraordinary shaped large reflectors will find, if he replaces it intelligently by a cone reflector of same diameter at mouth and same depth, that he will get at least 25 per cent. more light, and in some cases 50 per cent. more.

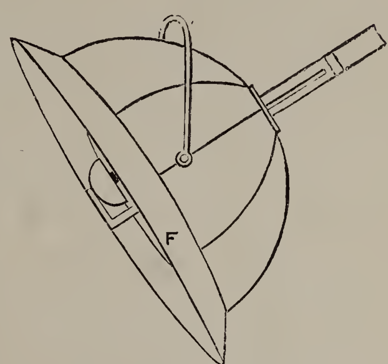


Fig. 7.

Fig. 7 represents a form of reflector found in many studios. The flange, F, is a mysterious affair. What useful purpose it serves one cannot conceive; it, however adds considerably to the weight and first cost.

Fig. 8 is another still more extraordinary reflector, in which a diaphragm or stop is fixed on the mouth of a large umbrella reflector, reducing it from an opening of 48 inches or 54 inches to 36 inches or 42 inches.

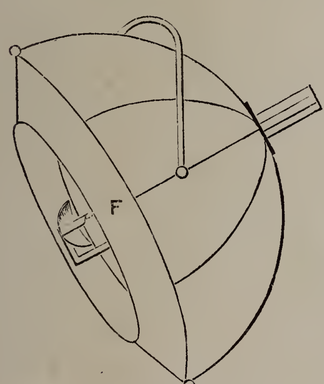


Fig. 8.

If the flange, F, in Fig. 8 were silvered and polished, it might be effective in some small degree in concentrating the light into the crown of the umbrella, and thus increasing the direct light through the aperture; but direct experiment proves that it does not increase the light, and, what is more significant, it does not *reduce* the light to any appreciable extent—a very striking proof that the sides of the umbrella are useless as a reflector, for F, in Fig. 8, cuts off the light if any is reflected forward from the sides. That it cuts off only a small fraction proves that

the sides reflect only that small fraction in a forward direction. The flange in Figs. 7 and 8 is a sort of freak; it cannot possibly have any optical, mechanical, or other earthly effect whatever.

It has been suggested that it is put there as a sort of handle for the operator to grab when he wants to pull the apparatus about. A door-knob would, however, seem to be a cheaper and more effective affair for that purpose.

No curved or umbrella-shaped reflector can equal the plane cone here shown, Fig. 9, for efficiency as a dead-white reflector; this is the best form for portraiture work.

A curved form is all right and proper for a mirror with a polished surface, but for a dead-white or matt surface a plane cone is far superior; the worst shape of all is a hemisphere, and it ought to be avoided.

A deep cone is required for alternating current arcs, and the arc should be well up into the cone, about half way in. The cone should be 2 feet deep for alternating arcs, and 16 inches for continuous arcs when it is 4 feet 6 inches wide.

The continuous current arc may be worked well down, about level with the mouth of the core, and with the positive the lower carbon.

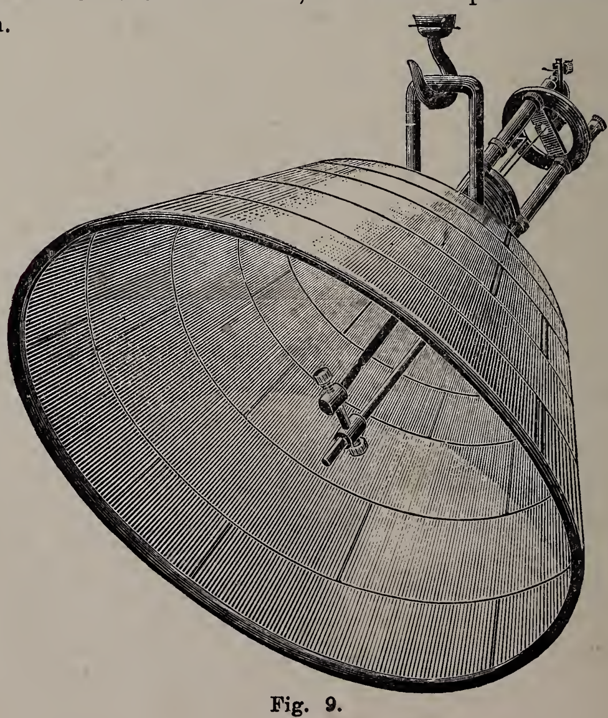


Fig. 9.

Artificial light for photography must be made to resemble daylight as much as possible in every way, but more especially in the direction in which light falls; for this reason large surface reflectors are used.

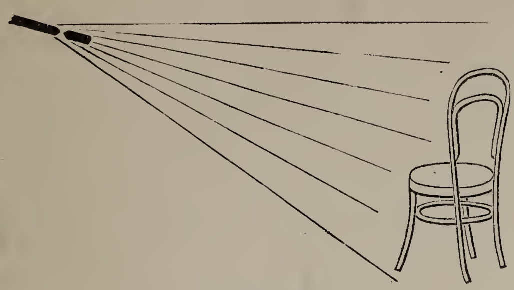


Fig. 10.

In Fig. 10 is illustrated the fall of light from an arc light It falls as a conical beam and in straight lines from a single point thus producing hard, sharp shadows and profiles, and an unnatural appearance.

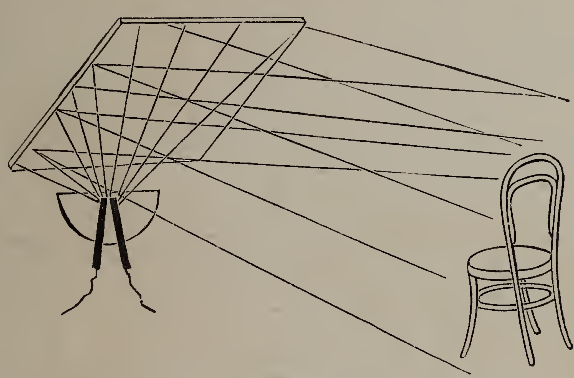


Fig. 11.

In Fig. 11, we have an arc in a bowl to screen off the direct light which is thrown up on a dead-white reflector, and powerfully illuminates the whole surface. From this surface the light is thrown forward, principally in parallel lines, and also in crossing lines, in every different plane; this is like daylight, mixed light or diffused light, and gives a photo a beautifully soft, natural appearance.

In Fig. 12 we have the conical reflector, which also gives light, principally falling in parallel lines but crossed by other rays at all angles, thus giving the desired diffusion of the light falling on the sitter.

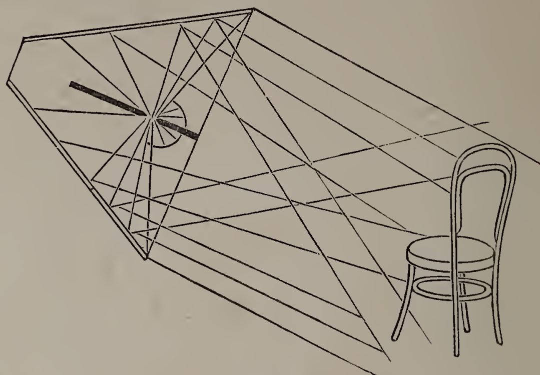


Fig. 12.

How the light falls from the umbrella and other extraordinary shaped reflectors is a matter not worth considering here. The problem may be left to the scientific photographers who use them.

We may now describe another style of photo-electric plant which has only recently come out.

A diagram of this method, with one lamp and one screen, is shown in Fig. 13.

S is a light, portable canvas screen, pure white on surface, and with a folding top wing to throw light downwards; it may have the dimensions marked in the Fig. 13.

The lamp should be about 4 feet 6 inches or five feet high, and swivel up and down and in every direction.

The light is thrown on the screen and from thence upon the sitter.

With two lamps throwing their light on the screen, and by judiciously placing the screen with relation to the sitter, very fine photographic work can be executed.

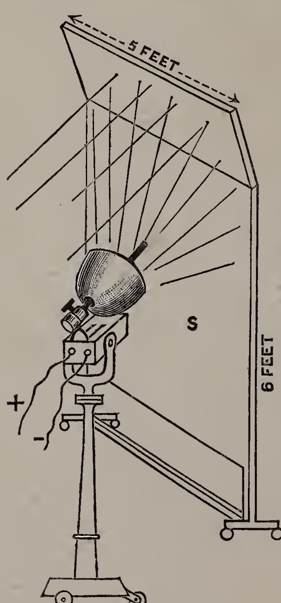


Fig. 13.

This plant is entirely portable, and can be stowed away when not required. The lamps and reflector being separate, much more variety of work can be done, and a clever operator working with two screens and two lamps can produce artistic effects hitherto unapproached.

The Sun Lamp and many other lamps are suitable for this class of work. But perhaps the best type of lamp for the purpose is a search-light lamp like Crompton and Co.'s (Fig. 14), mounted

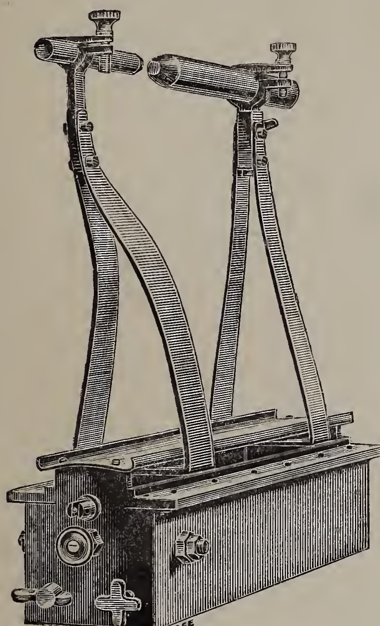


Fig. 14.

on a universal stand, and with an enamelled iron bowl to screen the light from the sitter and throw it on to the movable white reflector screen. There is very little mechanism in it and that of the simplest. Its steadiness is quite unaffected by the movements of the projector, in fact it will burn equally well in any position. By turning the star nut shown in the illustration the lamp may be converted from an automatic lamp to a hand lamp, the feed being then effected by the milled head screw. By means of this star nut the automatic motion is disconnected both electrically and mechanically. The thumb-screw, which acts on the feeding mechanism, is for adjusting the length of the arc.

It is as well to make the lamp-stand telescoped to rise and fall, and the lamp to swivel.

This method of photo work is by far preferable to swinging lamps, and has much to recommend it to photographers.

Another modification of the method worked out by the author is to have the reflecting screen and lamp on one stand. This is very good for small studios—is cheap and effective. The lamp is an inverted lamp of ordinary make, with a conical reflector, as shown in Fig. 15. A plane reflector 3 feet 6 inches,

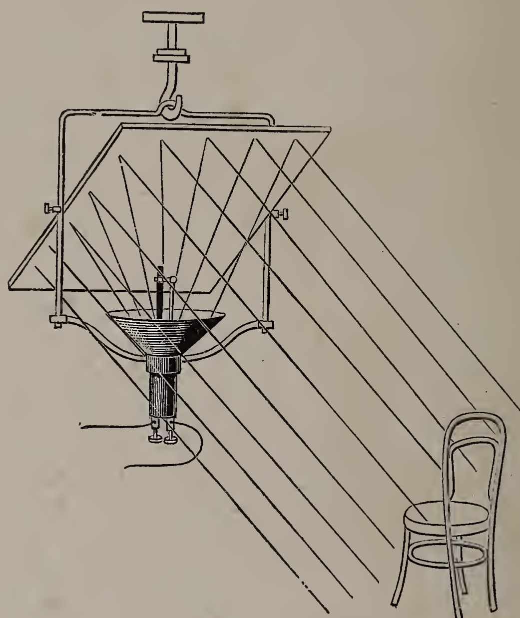


Fig. 15.

or 4 feet in diameter, if circular, or the same size square, is pivoted on a light, rectangular frame; this reflector is of dead-white surface, and can be angled to produce various effects. A painter's canvas stretched on the usual frame makes a very good reflector for this purpose and is perfectly safe in this case, as the lamp is below it.

The method of employing a separate portable lamp and reflector, as shown in Fig. 13, is one which is bound to come into favour, as it gives the photographer entire freedom in manipulating his lights.

Chapter II.

LAMPS AND LAMP REGULATORS.

Some lamps have no regulators, being hand-fed. The carbons burn away, and as they burn silently and with a maximum of light when maintained at one constant distance apart, it is important that the mechanism of the lamp should properly effect this continually feeding forward of the carbon as it burns away. When the feeding is by hand, the mechanism is usually a pair of screws, one right, the other left, as shown in Fig. 16, one of Verity's. By turning the hand-wheel at the lower end of the screws, the carbon-holders are moved towards or away from each other, so that by this simple means the length of the arc can be readily adjusted.

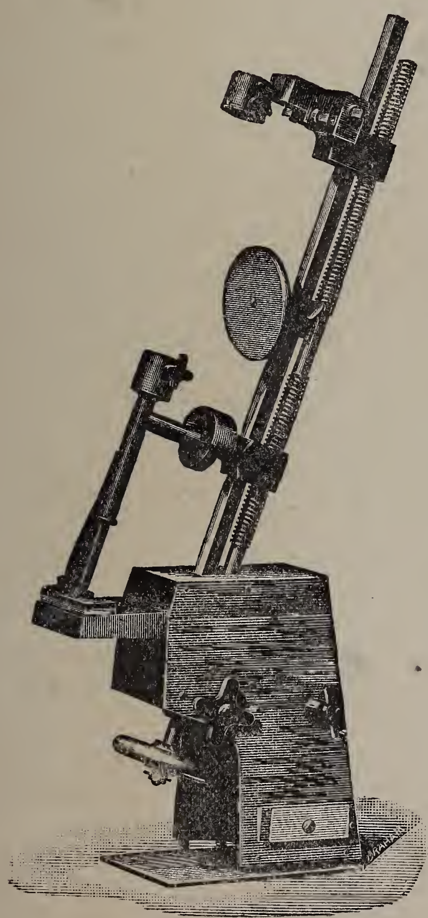


Fig. 16.

This construction is massive and calculated for large currents of from 50 to 100 ampères, and it is generally mounted in front of a mirror for projecting the light forward in a straight beam, and is used for search lights in the army and navy.

For most photographic and optical purposes a small, cheap hand-fed lamp is all that is necessary, as hand-fed lamps are only used for temporary purposes, automatic lamps being preferable for continuous use.

A very simple hand-fed lamp, suitable for lanterns, enlarging, and copying on a small scale, and one which can be constructed by any brass worker for a few shillings, has been designed by the author, and is illustrated in Fig. 17.

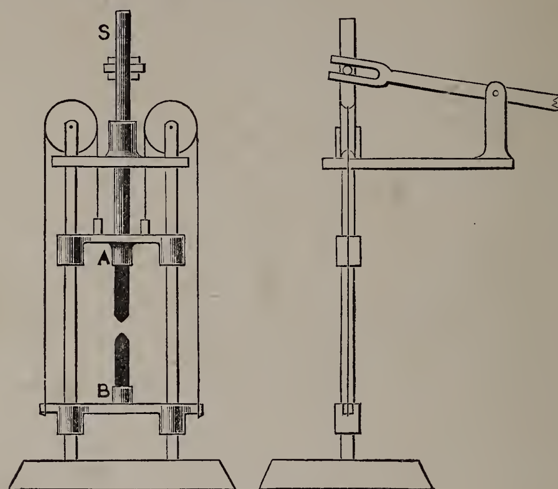


Fig. 17.

Two guide-rods are fixed in a base-plate, and running easily upon them are the two carbon-holders, A, B, hung over pulleys; the upper carbon-holder has a spindle, S, guided through a collar on the top plate; a lever works in a slot in this spindle, and by means of the long end of this lever the carbons can be easily approached or drawn away from each other to regulate the length of the arc.

Later on I shall describe how to make this into an automatic lamp.

Fig. 18 is a sketch of the author's design for a hand-fed lamp for portraiture work; it also is easily made up of simple materials, and as it is an important apparatus it will be described in full.

A large reflector is made of zinc for lightness, or of thin tinned iron; it is 4 ft. or 4 ft. 6 in. in diameter, and about 16 in. deep; a flange, W, secures the lamp in the crown of the reflector fixed on the main tubes P. This tube is $1\frac{1}{8}$ in. outside diameter of stout brass, and is 30 in. long. At the lower end is carried a carbon-holder, for a 20-millimetre carbon, B, and on the carbon-holder, B, a small enamelled iron bowl is fixed to act as a

reflector, and to screen the direct light from the sitter. These bowls are sold by hardware people for kitchen use at about 8d. to 1s. each.

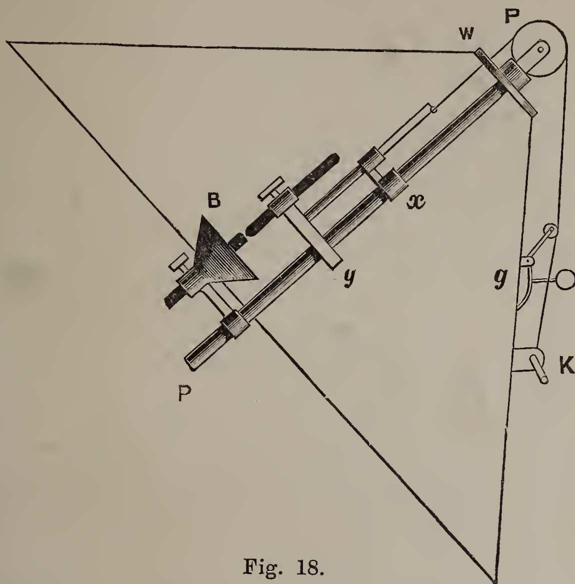


Fig. 18.

The tube, P, carries two guiding-eyes, x, y, guiding a $\frac{5}{8}$-in. brass tube carrying the upper carbon-holder, which takes a 15-millimetre carbon rod. A cord passes from this tube over a pulley, P, and down to a small winch, K, by means of which the arc can be regulated perfectly. At g is a small pulley on a rocking arm, with sufficient back weight to open the arc. By tipping up the ball smartly with the finger the arc is easily and beautifully struck up without a dangerous rush of current after the arc is struck; the feeding can be kept up by unwinding the cord from the winch. Normally when no current is passing the two carbons should be $\frac{1}{8}$ or $\frac{3}{16}$ in. apart.

The small hand-fed lamp, Fig. 17, can be used with any current, and up to a power of 70 ampères, and will work down to 1 ampère; it will require from 40 to 45 volts continuous, and 28 to 35 volts alternating current.

The portraiture hand-fed lamp will work also with any current, and takes from 40 to 70 ampères, and a pressure of 40 to 50 volts continuous current, and 30 to 40 volts alternating.

The necessary resistances must be used for each, and found by calculation, as before directed.

Hand-fed lamps are exceedingly handy at times, and a little practice enables one to work them with perfect arcs. They do not get out of order readily, and are cheap.

Fig. 19 illustrates Borland's Hand-feed Scissors Lamp—a simple and effective little lamp for lantern work.

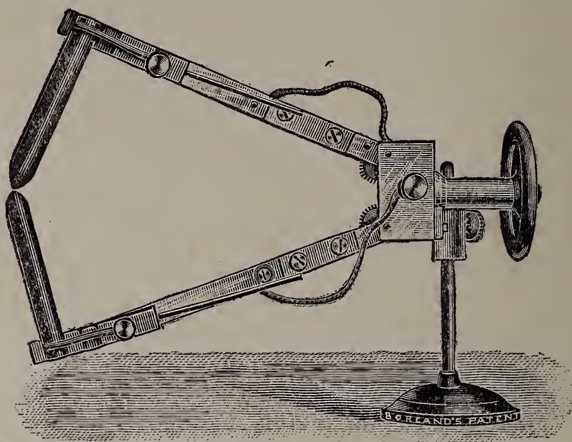


Fig. 19.

Joel's Hand-fed Photo Lamp is shown in Fig. 20, with its suspension gear and reflector.

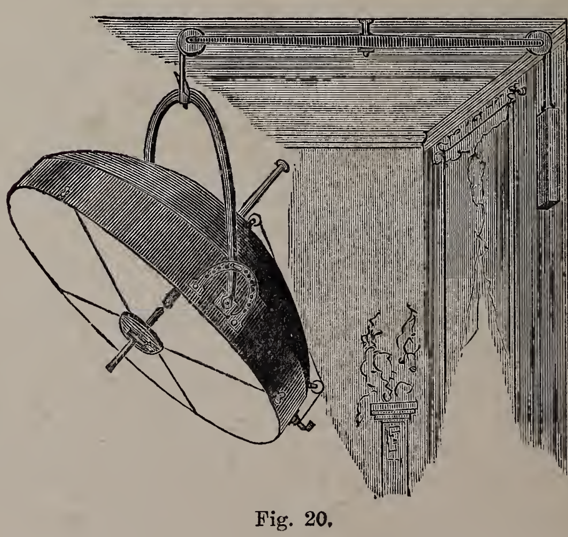


Fig. 20.

It is made to hand-feed the carbons with an endless screw action, and it is effective and reliable. Messrs. Joel & Co. also make a self-feeding automatic lamp, using the Pilsen core and coils, and this lamp will burn continuously for some six hours, with a steady arc, and in either a horizontal or vertical position.

The arc-lamp, Fig. 21, has been designed by Mr. Davenport, and is constructed by J. H. Steward for use in the ordinary size optical lantern, such as used for three-wick oil lanterns, without alteration, and, with the back plate modified a little to that shown in illustration, will go into all lanterns having openings at the back. All these hand-fed lamps work centrally, and require no more attention than the limelight—in fact, it is only necessary now and then to turn the milled head of pinion, and bring the top carbon down a little. The bottom carbon is fed automatically, and the point remains in

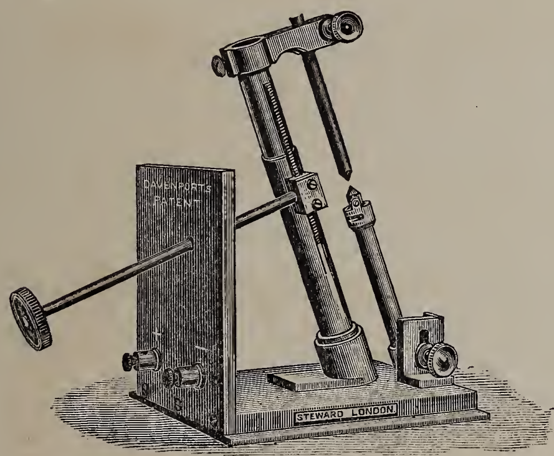


Fig. 21.

ONE-FOURTH ACTUAL SIZE.

same position as when first adjusted by the slotted mount and clamp screw near the base. The carbons can be quickly changed, but are long enough for an average entertainment. The arc light being of small area enables splendid definition to be obtained; and for ordinary projection of photographs, microscopical work, and all optical experiments, as well as enlarging, will be found invaluable. As direct or continuous currents of electricity are

now supplied to so many private houses, as well as to nearly all the large halls, institutions, colleges, and societies' places of meetings, clubs, &c., it is thought that a long-desired want has been supplied, by the facility given to demonstrators, lanternists, and the commercial world, of getting a most brilliant and steady light at a moderate cost, as a first outlay, and little or no expense to lecturer in working where current is on.

The object sought has been to provide a lamp, simple in design, easily understood, and capable of being used by persons unacquainted with electrical science.

The lamp consists of two carbon-holders, so arranged that, while the lower carbon is automatically maintained in the proper position for burning by a spring within the lower carbon tube, the upper carbon is fed forward from time to time as the carbon is consumed, by a rod at the back of the lamp attached to a rack-and-pinion arrangement. It will burn about five minutes without attention or any sensible diminution of the light should the operator not be able to turn the rod.

The tube containing the lower carbon is fastened by a thumb-screw to a fixed upright plate, having a slot cut in it so that the height of the tube may be varied and other adjustments made. The two carbons are set at an angle so that the full benefit of the arc is obtained directly in front.

The lamp is made of such size and shape that it will fit any ordinary lantern without alteration, thus allowing of the lime-light or other luminant being used when the electric current is not available.

The rod carrying the pinion for feeding the upper carbon projects at the back of the lantern, and the only attention necessary in using the lamp is to turn this rod from time to time in a similar manner to that required when turning the lime for the lime-light.

The lamp is perfectly steady in working, and gives a light capable of being varied to a greater or less degree by suitable resistances.

In all cases where a large disc has to be covered, the greater power of the electric light is a distinct advantage over the lime-light, while its purer colour enables much better results to be obtained.

For scientific demonstrations, the projection of microscope slides, and for experiments with reflected light, and other purposes

where the loss of light is great, the arc lamp is invaluable, as it is impossible to obtain satisfactory results with any other luminant except on a very small scale.

The following are the necessary working instructions supplied with the Davenport lamp :—

The lamp should be worked with from six to eight ampères of current, and requires an electromotive force—E.M.F.—of not less than 60 volts. A resistance should be placed in the circuit, varying according to the E.M.F. employed.

The amount of resistance necessary may be ascertained approximately, as before described, if the E.M.F. required to overcome the resistance of the arc itself be reckoned at 45 volts. The difference between this E.M.F. and the E.M.F. of the main circuit should be divided by the amount of current in ampères required in the lamp, and the resultant will be the amount of resistance in ohms. Examples :—

E.M.F. in supply circuit = 101 volts

$$101 - 45 = 56$$

Volts.		Ampères.		Ohms.
56	÷	7	=	8

E.M.F. in supply circuit = 59 volts

$$59 - 45 = 14$$

Volts.		Ampères.		Ohms.
14	÷	7	=	2

All lamps will work much better when the higher E.M.F. is used, with a proportionately higher resistance.

The positive terminal of the lamp (marked +) should be connected to the positive terminal of the supply circuit, and the negative terminal (marked —) to the negative or return terminal of the supply circuit. The resistance may be inserted in either the positive or negative portion of the circuit. A fuse should be inserted in the main circuit near the terminals for the lamp supply, capable of carrying about 15 ampères before fusing.

Wires equivalent to not less than No. 14 B.W.G. should be employed for the branch of the main circuit supplying the lamp, and also for the flexible wires connecting to the lamp.

Carbons should be 8 M/M. in diameter, cored carbons being used for the upper or positive carbon and solid ones for the lower or negative carbon.

This lamp can be used for copying and printing on a small scale.

The Jablochkoff candle, as modified by Rapieff, is used for a Photo-Electric Lamp as described later on. Fig. 22 represents this lamp.

Two carbon rods, inclined to each other, are drawn apart when the current passes, and so form the arc; they are specially suited for alternating current working, and, by exercising a little care, can also be used in continuous current circuits by manipulating a reversing switch every five minutes.

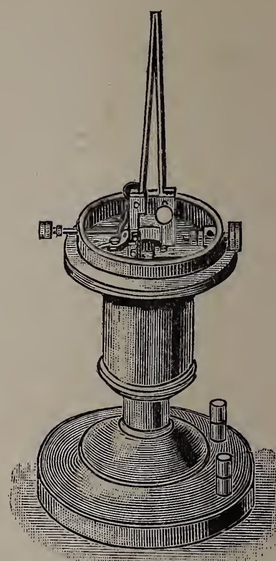


Fig. 22.

The Jablochkoff candle can also be used for lantern work, enlarging and other purposes in the form shown in Fig. 23.

The coil of wire in front keeps the arc always at the tip of the candle, and the candle can be pushed through the holders as it burns away. The current must pass through the coil and arc in series.

An oblong coil laid alongside of the candle is sometimes used to keep the arc to the point, but no coil is needed if the candle is slightly tipped up so that the arc is the highest point. An angle of 30° with the horizontal is sufficient.

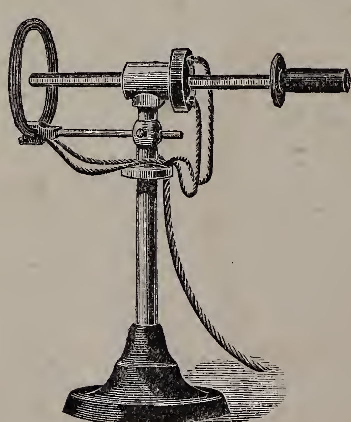


Fig. 23.

To make the small hand-fed lamp automatic it is only necessary that the lower carbon-holder should carry an iron cone, I, which may be of the double-tapered form—that is, it has about $1\frac{1}{2}$ in. plain in the middle, and tapers to both ends to a point an $\frac{1}{8}$ in. diameter or $\frac{3}{16}$ in. The middle $1\frac{1}{2}$ being $\frac{5}{8}$-th iron, the two bobbins, A and M, are formed on a vulcanised fibre rod, about $\frac{7}{8}$-th inside bore, by fixing on four flanges 3 inches apart. The tapered core is carried in a thin brass tube fixed to the lower carbon-holder A. A is the

fine wire shunt coil which feeds the carbons together, and should consist of No. 30 B.W.G. single cotton-covered copper wire, 2 lbs. being enough. The bobbins should be about 3 inches outside diameter.

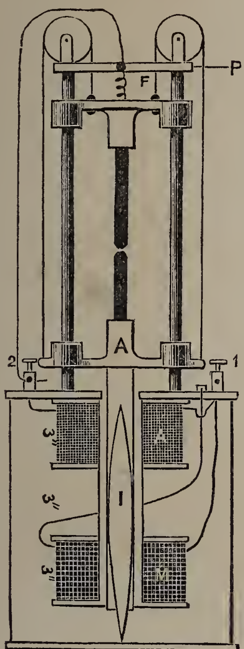


Fig. 24.

The thick wire, bobbin, M, is wound with cotton-covered copper wire of a size to carry the current for which the lamp is wanted. Five layers of No. 10 B.W.G. will do for 15 to 20 ampères; for a lantern-lamp of 8 to 10 ampères, No. 14 wire, in 8 layers, will do.

The upper carbon-holder has to be weighted until the carbons just move together by their weight; the construction is obviously simple, and the main current passes through the thick wire and then on to the lamp-frame.

The upper carbon-holder is insulated from its carrier and connected to the other terminal by a flexible wire, F. The shunt is connected across the two terminals, all as shown in Fig. 24.

Another simple automatic optical lamp is that by Borland, of Leeds, known as the "Scissors" Lamp, shown in Fig. 25. Cores working on the short end of the levers open or close the arc, and

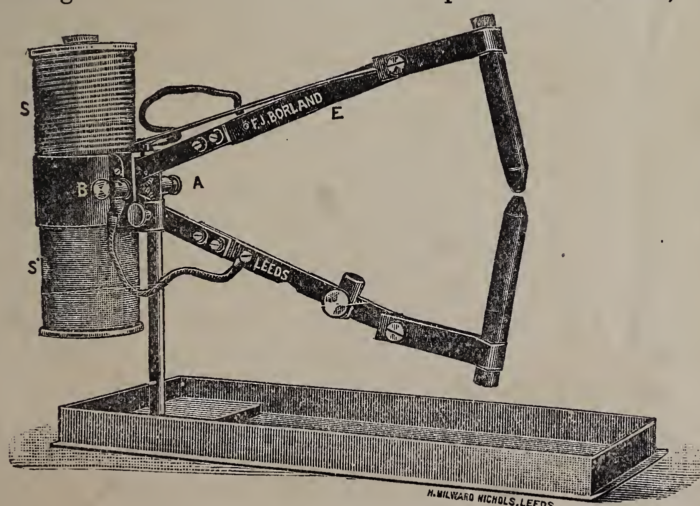


Fig. 25.

the arrangement is exceedingly simple and goes into a small lantern easily ; it works with continuous current, and can be made also for alternating current. We now come to the

PLANET LAMP.

This lamp is an excellent design of an automatic arc-lamp fed by screw and motor gear. It is not an entire novelty in arc-lamp mechanism.

A lamp for scenic purposes must be simple and reliable, and be capable of working in the most unskilled hands, and, most important of all, should have no loose parts to dangle about when the lamp is inclined ; in fact, the mechanism should work equally well whether it stands upright, is inclined to any angle, or laid on its side.

The Planet lantern-lamp appears to meet these requirements, so far as a continuous current lamp is concerned, but we are not informed whether the lamp can be used for alternating currents or not.

The accompanying illustrations show the various parts of the lamp in detail. In Fig. 26 the lamp is shown partly in section, with one field magnet removed.

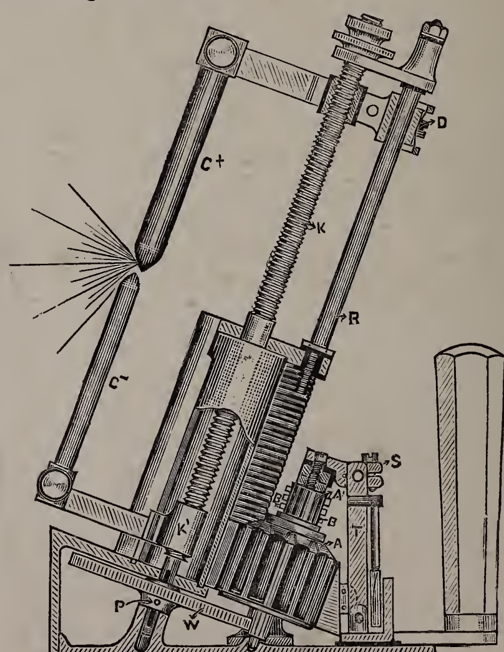


Fig. 26.

C + and C — are the positive and negative carbons; these are proportioned so as to burn at an equal rate. The carbon-holders are arranged to be moved in either direction by the screwed shaft, K, by means of the threaded collars or nuts. The upper and lower portions of the shaft, K, are threaded right and left hand respectively, so that the two carbon-holders always move in opposite directions. The toothed wheel, W, is keyed on to the shaft, K, by the means of the pin and slot, P, which leaves the shaft free to move through a certain distance, in order to adjust the arc vertically to the focus, by moving both carbon-holders simultaneously. This movement is effected by slackening the lock-nut and turning the milled nut in either direction, according as the arc is above or below the focus; this adjustment does away with the necessity of a separate levelling-table. The armature, A, of the electric motor drives the wheel, W, by means of a small pinion. The field magnets of the motor are wound with several layers of thick wire, through which the current flows to the + carbon by way of the copper guide-rod, R, and sliding-block, D. B and B^1 are metal brushes, through which current is conveyed to the armature coils. S and F are two platinum-tipped screws, which, together with the metal tongue, T, and the soft iron bar, Z, form the relay by which the supply of current to the armature is directed and controlled. By adjusting these two screws the length of arc can be regulated at will. When the tongue, T, touches the screw, F, a small current, derived from part of the resistance passes through the armature, causing it to turn, so as to feed the carbons together; and when the tongue, T, touches the screw, S, the current is reversed, thereby reversing the direction of the armature, and separating the carbons.

NEWTONIAN LAMP.

The Newtonian Optical Electric Lamp is among the latest forms. It is automatic in its action, and has a very perfect and complete movement for hand adjustments; altogether it is a beautifully-made and well-designed lamp in the various forms.

The automatic feed is one of great simplicity. It is an abutment feed. The ends of the carbons abut against three screws in the carbon-holders so that the carbons project only their points,

but, as they burn away, the springs behind the carbons push them forward, just as a candle in a carriage-lamp feeds up.

Abutment feeding is not new; it has been applied to the negative carbon before now, but not before to both carbons.

One great difficulty in the use of the Electric Arc light in lanterns has been the impossibility of obtaining at a reasonable cost a lamp which would give a steady light without constant attention. Hand-fed lamps requiring adjustment every two or three minutes were found to be a great inconvenience, while a really good automatic lamp not only cost £15, but required a special lantern of large size for use with it.

In the Newtonian lamp, Major Holden, R.A., has designed a lamp which is self-feeding and focus-keeping, and which yet dispenses with coils, magnets, and all similar complications, and depends entirely on simple mechanical arrangements which can be readily understood and managed by any lanternist.

The lamp works well either from dynamos or accumulators, and is made to clamp on the rod of the tray of any ordinary lime-light lantern. In the Fig. 28 it is shown clamped on the rod of one of the adjusting trays.

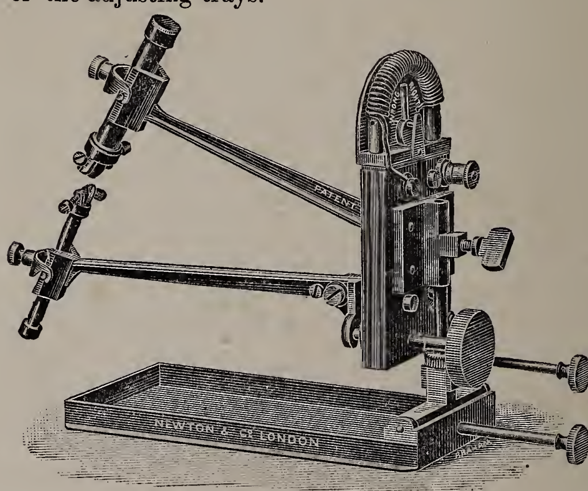


Fig. 28, Pattern A.

In cases where the electric current is not laid on, it may be obtained from accumulators, which can be charged as often as necessary. The following particulars may be useful :—

Thirty-four portable cells in wood boxes, with lids, will give a current of nine ampères at 65 volts, for three hours. Each cell

measures $3\frac{1}{8}$ inches × $7\frac{1}{8}$ inches × $13\frac{1}{2}$ inches over all. Total weight about 5 cwts. Price £27 14s.

Voltage and Current.—Either of the lamps, pattern A and B, can be used wherever there is a supply of electric current (direct, or alternating) available, the requirements being not less than 60 volts and a current between 4 and 10 ampères; under 4 ampères the light is insufficient for ordinary lantern purposes, and above 10 ampères the heat evolved is too great for lanterns not specially constructed; about 8 ampères is desirable for most purposes.

Added Resistance in Circuit.—A resistance varying with the voltages of the supply and the current used in the lamp must be included in the circuit with the lamp, the proper amount being shown in the table of resistances.

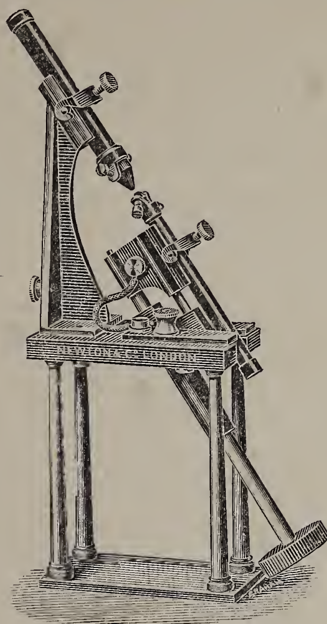


Fig. 29, Pattern B.

IRON WIRE.

Table of Resistance for Various Voltages and Currents.

Current ampères.	Resistance in ohms for Volts.							Iron Wire of suitable size.	Feet per ohm.
	60	65	70	80	90	100	110		
4	4	5	6·2	8·7	11	14	16	·035 No. 20 BWG	18
5	3	4	5·5	7·0	9	11	13	·049 No. 18 BWG	30
6	2·5	3·5	4·5	6 0	7·5	9	11	,,	,,
7	2	3	4	5·0	6·5	8	9	,,	,,
8	1·9	2·5	3·5	4 5	5·5	7	8	·065 No. 16 BWG	60
9	1·7	2·2	2·7	4·0	5·0	6	7	,,	,,
10	1·5	2	2·5	3·5	4·5	5·5	6·5	,,	,,
11	1·3	1·8	2·3	3 2	4 1	5·0	5·9	·083 No. 14 BWG	95
12	1·2	1·7	2·1	2 9	3·7	4·6	5·4	,,	,,
13	1·2	1·5	1·9	2·7	3·5	4 2	5·0	,,	,,
14	1·1	1·4	1·8	2·5	3·2	4·0	4·6	,,	,,
15	1·0	1·3	1·6	2 3	3·0	3 6	4 3	,,	,,

The cost of the above resistances in a simple portable form is from 15s. to 45s., according to the current.

Diagram of connections, Fig. 27, for 8-ampère A pattern Newtonian Lamp on 65 volt circuit.

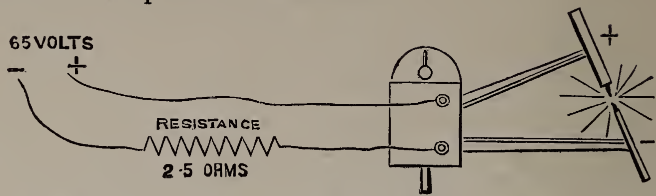


Diagram of connections, Fig. 27, for 10-ampère B pattern Newtonian Lamp on 100 volt circuit.

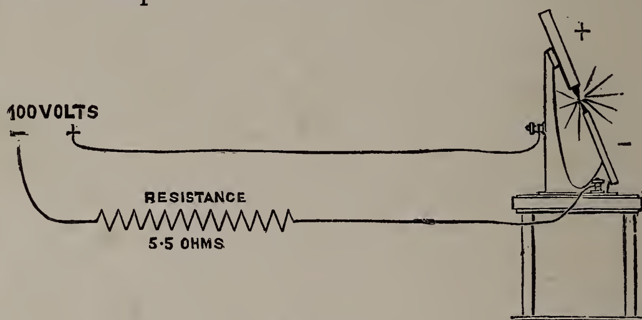


Fig. 27.

The makers put these lamps forward for continuous current only, but they may equally as well be used with alternating currents. If both carbons are made the same in diameter they work better with alternating current than when the negative is thinner than the positive, as in the lamps usually made.

Messrs. Newton & Co., Fleet Street, make these lamps in every required form and size.

THE KRUEGER ARC LAMP.

Fig. 30.—This lamp was designed and is specially adapted for use in theatres, halls and public buildings, and is claimed to be the best means for obtaining brilliant lighting effects for stage work. It takes the place of the calcium light, and is stated to be superior to it in many respects, as it is easy of transport, and far more economical.

In the accompanying illustration the lamp is shown attached to its supporting stand, equipped with a silvered parabolic reflector; but the lamp is so arranged that the reflector can be quickly and easily removed, and a lens box or Olivette box substituted for it, making it possible to use a single lamp for varied effects.

The illuminating power of the lamp is said to be 3,000 candles, and owing to the simple but ingenious mechanism, the light is maintained very constant. The lamp is practically noiseless in its operation, and owing to the entire absence of any devices depending upon gravitation in the regulating mechanism, it can be inclined to any desired angle without interfering with its operation, and without any re-adjustment.

In operating the lamp, connection can be made direct to the supply wires of a 110-volt constant potential lighting system, observing that the current passes in the right direction through the carbons, and under these conditions the rheostat in the perforated cone at the base of the lamp will reduce the current passing through the lamp to the proper strength.

The lens box is used when it is desired to concentrate the rays of light more or less according to adjustment. It is very useful in cases where it is desired to throw a strong beam of light upon a moderate-sized object upon the stage, or to follow an object in its movements.

The Olivette box is used when a uniform dispersion of light over a considerable area is desired, which result is secured by means of a ground glass front. In front of the ground glass a colour frame is provided, open at both sides, so that frames can be slid through in succession, and the colours changed without showing the white light.

The Krueger lamp is manufactured by the Western Electric Company, of Coleman Street, E.C.

PILSEN-JOEL ARC LAMP.

The lamp, Fig. 31, is one of the P 13 type—a stand lamp—and is fitted on the adjustable camera stand, and designed and used in many installations for printing photographs and reproducing photo-engravings, and such work, and gives a nominal 6,000 candle-power. The light is reflected with increased power on any special object. The reflector is adjustable in any direction, and the lamp, with reflector only, without the stand, is useful as a search lamp or cargo lamp, and for signalling and other useful purposes. The light is exceptionally steady and reliable; the Pilsen lamp is, as is well known, very simple in construction, being self-regulating by the electric current only, and has no clockwork or tooth-wheel gearing, and is easily manipulated and kept in working order by any intelligent workman.

Ordinary arc-lamps, such as are used in lighting, can be used for photo-printing, and are much used for that purpose, although they are by no means well adapted to it.

Any make of lamp for 20 or 25 ampères will serve this purpose, two of them being used in series, and the light from each lamp thrown on the print from opposite sides.

Fig. 32 represents a focussing Crompton Pochin lamp, which is as good as any other for the purpose, and which are now cheap. They work well with alternating current. In adopting ordinary lamps for photo purposes, one must see that he gets a lamp for alternating currents if he is in an alternating current district.

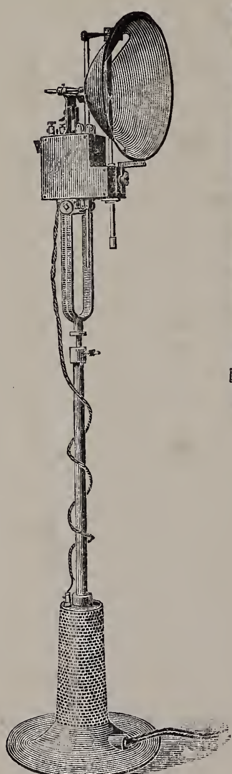


Fig. 30.

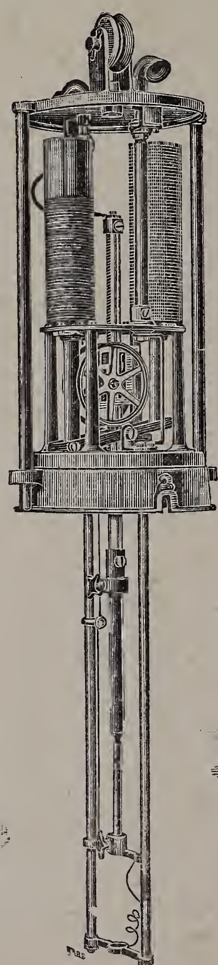


Fig. 32.

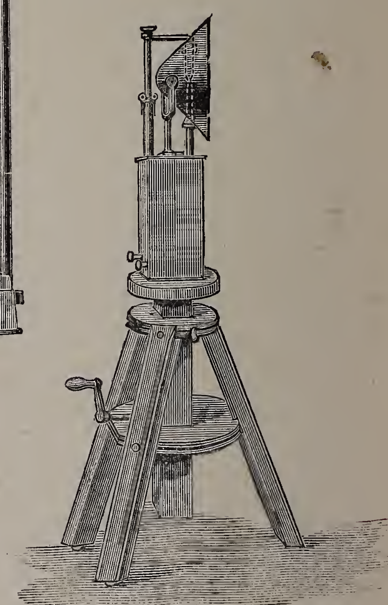


Fig. 31.

Many lamps go equally well on any circuit. Among these are the Crompton, Brush, Brockie-Pell, Kennedy, and Lewis lamps. It is only necessary in ordering to state the kind of current supplied and the frequency.

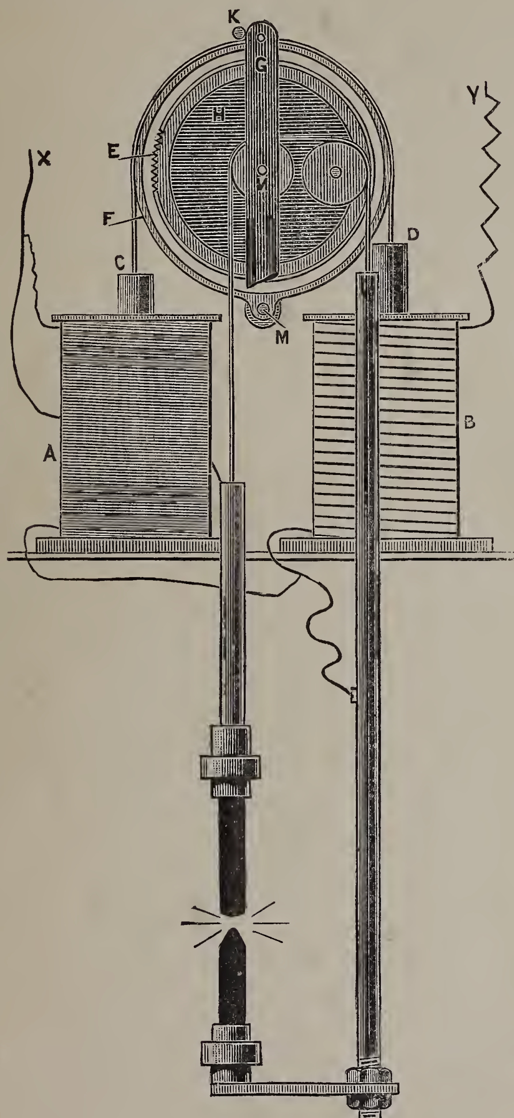


Fig. 33.

Fig. 33 is a Kennedy hanging arc-lamp. To adopt it for printing purposes a conical reflector is fitted as in Fig. 34. This

reflector is about 20 inches diameter and six or eight inches deep, of common iron, and kept brilliantly white inside with pure whitewash made of clean whitening and clean water, into which clean isinglass is added to make it adherent.

The reflector is hung usually by an iron strip, bolted to the frame of the lamp.

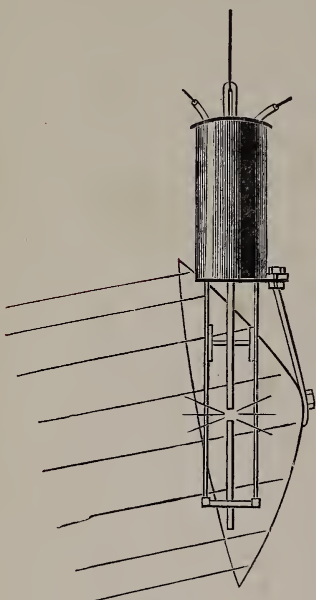


Fig. 34.

A focussing lamp is almost necessary in every case for this purpose.

The reflector is slotted out so as to clear the lamp rods.

For photo printing, on a large scale, the ordinary lamp so fitted is very wasteful, and a better arrangement is shown at Fig. 35. Here a large hood, made of sheet iron or zinc, is fixed to a deal bench for printing over a surface of 5 × 3 feet. The hood is made 5 ft. × 2 ft. 6 in., and three arc-lamps are placed inside, preferably of the Fig. 11 type; or any other good lamp which stands upright may be used. The author's Fig. 11 type is cheap and handy.

With three lamps, of 20 ampères each, and with the hood brilliantly whitewashed, an engineer's or architect's tracings can be copied on blue prints in 15 minutes, with four lamps in 10 minutes; ordinary photographic negatives in the same time.

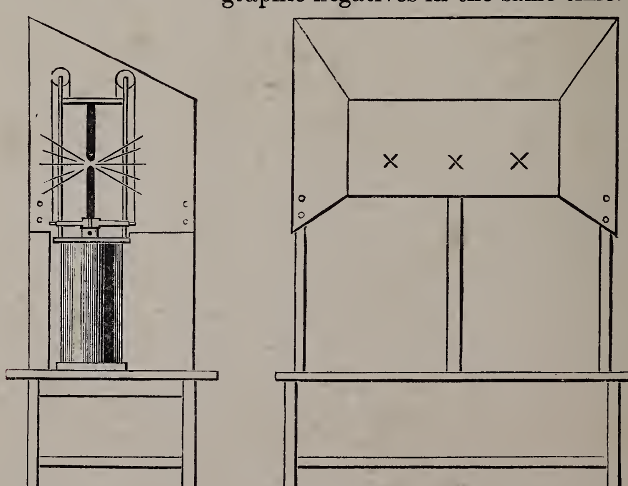


Fig. 35.

This is a simple apparatus, and can be built by any carpenter and tinsmith. It can be made very powerful, for into this hood five lamps of 20 ampères can be placed.

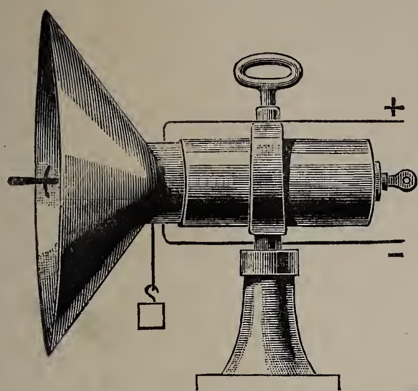


Fig. 36.

A still better arrangement is to use horizontal lamps in a conical reflector. And as this arrangement is good for either copying or printing and is the simplest arrangement, we will describe it at length.

Fig. 36 shows the appearance of a horizontal lamp with a conical reflector for one arc light. It may be hung or it may be on a stand, so that it can swivel in any direction.

The reflector is pure white inside and about two feet in diameter.

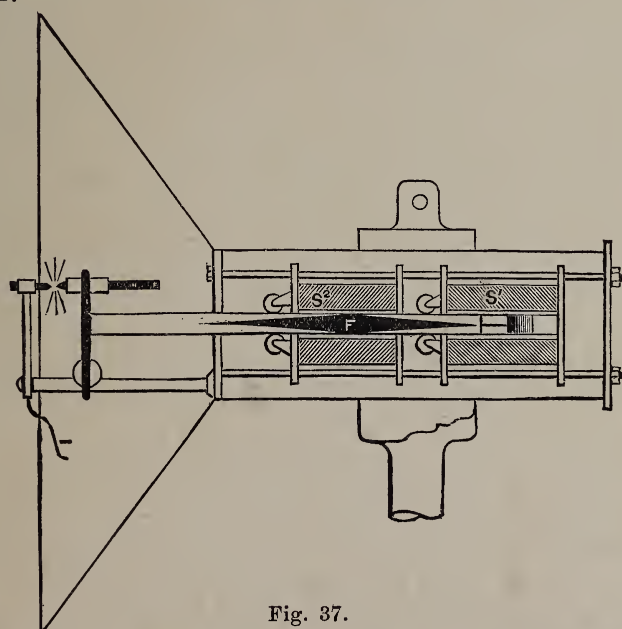


Fig. 37.

Fig. 37 is a diagram of the horizontal lamp for this apparatus. It is built on the Pilsen principle and is suitable for continuous

current working. The tube carries a double-coned core, F, working through two coils, S^1 and S^2; the tube is guided by two pulleys at its outer end, and by two smaller pulleys between the coils; a dash pot is formed of the lower end of the heavy wire coil, S^1. The reflector is fixed as shown.

Finding no very satisfactory horizontal lamps in the market, the author made some experiments in the hope of discovering a simpler and better arrangement, and with a view of making a

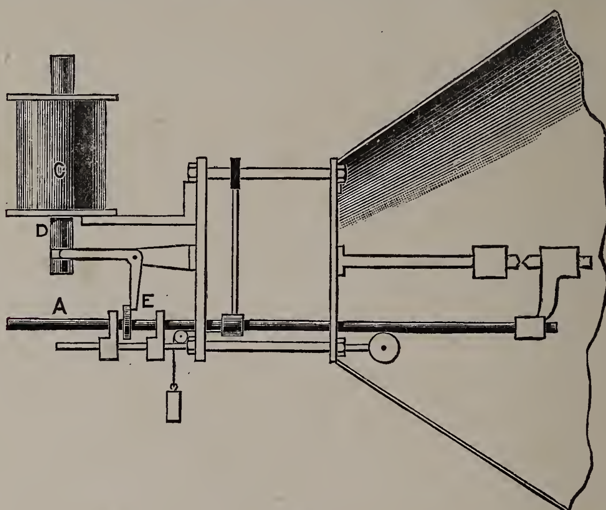


Fig. 38.

lamp equally suitable for any circuits, continuous or alternating, Fig. 38 is the result, and shows the construction diagrammatically.

It has only one coil, a shunt coil, and the arc is fed by this coil in opposition to a weight, which weight can be adjusted to a nicety by adding or withdrawing shot. The weight hangs on a cord over a pulley, which also acts as a guide-pulley.

The clutch, E, grips the rod, A, when no current is passing, and the weight draws the carbons apart, carrying the clutch on the rod; but when current is turned on, the iron core, D, is pulled down, and the lever, G, pushes back the clutch and rod until the carbons meet, the weight then overpowers the coil, and the carbons part to form the arc. As the carbons burn away the coil gets stronger, and pulls down the lever, releasing the clutch and allowing the lamp to feed.

Coil C is of fine wire; for continuous currents 2 lbs. of No. 30 B.W.G.

For alternating currents it is wound to suit the frequency, Nos. 26, 24, 22, B.W.G. wire being used for 83, 100 and 133 frequency. The core is $\frac{3}{4}$-in. laminated iron, the bobbin is made of vulcanised fibre, and is 4 in. long, 3 in. outside diameter of flanges. The core should not be less than 6 in. long.

Fig. 39 shows this lamp used in a large conical reflector, or, rather a hopper-shaped reflector. Four lamps are shown, in one

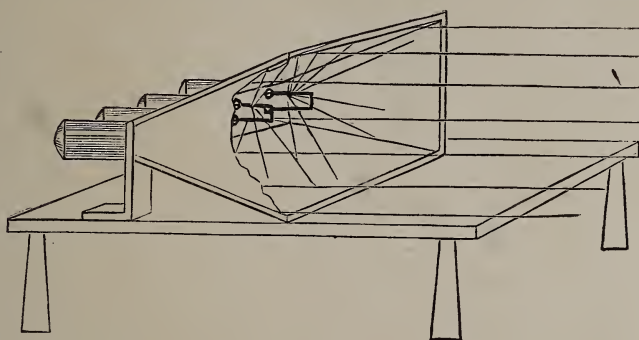


Fig. 39.

reflector, 5 ft. × 3 ft. at the open end. Such an apparatus is most effective; all the light is utilised, and a surface of 5 ft. × 3 ft. can be printed in a few minutes, with 20 ampère currents in each lamp.

We have hitherto considered only one lamp and reflector for portraiture work, namely, the hand-fed lamp (Fig. 10). The lamps described are principally useful for printing, copying, enlarging, &c.

AUTOMATIC PORTRAITURE LAMPS.

We now come to the consideration of Automatic Photo-Electric Lamps for studios.

We will consider the simplest and cheapest forms first.

About 12 years ago a good deal of interest was excited by the introduction of an arc-lamp known as the "Sun" lamp, or *lampe soleil.* In it the arc is formed across the face of a small block of marble. The surface of the marble becomes incandescent, and as the arc clings to it a remarkably steady, soft light is produced, much like good sunlight. The carbons do not burn away quickly, and the marble lasts from 12 to 20 hours, and is easily renewed. This electric lamp has been applied to photo-

graphic purposes by Mr. Boordman in a lamp made by Messrs. Nalder & Harrison, in the form suitable for portraiture shown in Fig. 40. The block of marble is held on the circular dish in the centre, and the two carbon rods enter, one from each side. The whole thing is small, compact and exceedingly simple, requiring no moving mechanism.

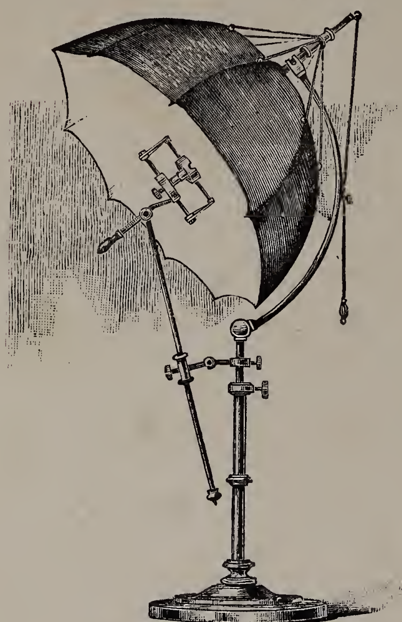


Fig. 40.

The marble, besides acting as a path for the arc, also acts as a reflector and throws the light up into an umbrella-shaped reflector of large size, as shown in the figure.

The whole arrangement is carried on a light stand as shown.

This is a somewhat primitive arrangement, but the makers can hang it on swivelling gear or on a rising and falling stand, and thus meet the requirements of photographers.

The important point in this apparatus is the lamp, which is simplicity itself and produces a powerful photographic light with any kind of current, alternating or continuous; and one point in its favour is its noiselessness under all circumstances.

It takes a good deal of current for the light produced, but that may be compensated by its simplicity and the good light it produces.

A better arrangement than the one shown is to have the electric lamp fixed in the reflector, so that both may be moved together when directing the light on a sitter, and a conical reflector would be an improvement.

The next arrangement for portraiture is one of the author's design, and is made for any kind of current. It is a clutch lamp, and is shown in diagram in Fig. 41. A single coil works a laminated core, which pulls up a clutch lifting the sliding rod and so forms the arc; as the arc lengthens the current

decreases and allows the rod to slide forward by the coil dropping the core and clutch. Fig. 42 is the general arrangement; at S is a universal joint and at S^1 another universal

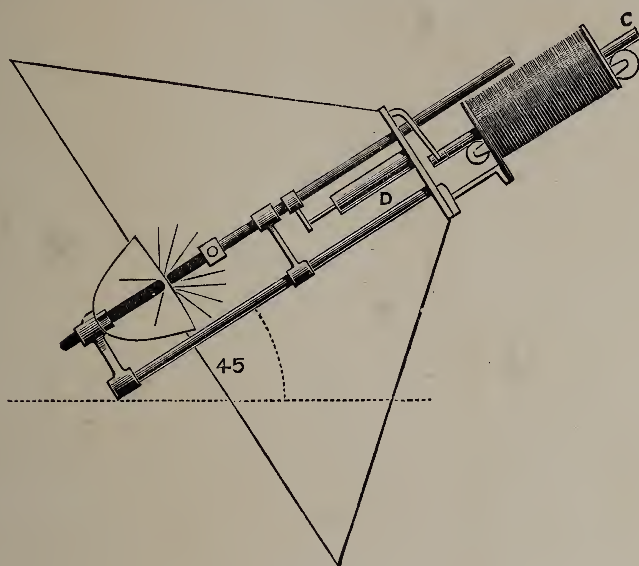


Fig. 41.

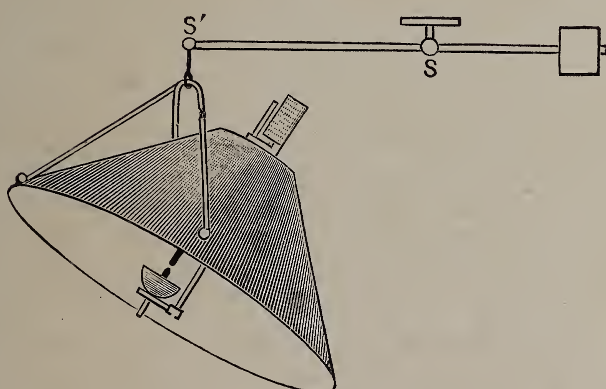


Fig. 42.

joint, so that the whole thing may be turned in any direction whatever, and it works with either kind of current.

The mechanism of the Planet lamp, before described and illustrated in Fig. 26, would make an excellent feed mechanism for these large portraiture lamps, but the most desirable mechanism

is one which will work on any current, and is therefore universally applicable.

The old clutch mechanism of Weston's lamp is an excellent one when used with laminated magnets.

The Pilsen lamp has long been made by Gwynne and Co. for a portraiture lamp. Fig. 43 is a diagram of this lamp

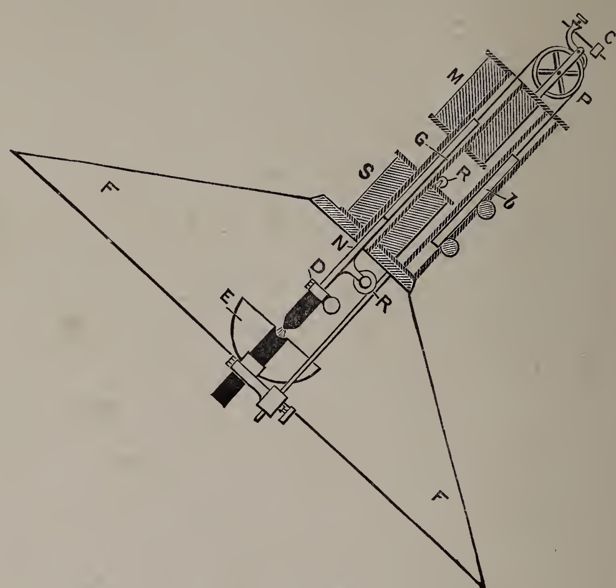


Fig. 43.

mechanism. A double-coned core works through two coils of wire, one a fine wire coil the other a thick wire coil; the cone is back-balanced by a sliding weight. When the lamp is properly wound for the current it is intended to use with it, the weight and the cone with all its attachments should just about balance each other. If any difference exists it should be in favour of the core, but no more than an ounce at most.

For continuous currents it makes a good mechanism for feeding the carbons, and is simple to make.

It is also made for alternating current circuits, the cores being laminated, and the special construction is patented for this purpose.

The author's apparatus, lamps, reflectors, and other electrical machinery are presently made by the Phœnix Dynamo Manufacturing Company, Hubert Street, Bradford, Yorks.

Fig. 44 is a view of the complete apparatus on a stand.

Another photographic portraiture apparatus is made by Adamson, of Glasgow. In this apparatus the lamps are incandescent lamps, each of 50 candle-power; 40 of them are used in each apparatus; they are arranged round the mouth of a circular umbrella-shaped reflector of thin silk stretched on a frame. Fig. 45 illustrates the complete apparatus on a swiveling frame. This frame is well designed for its purpose, and is a model of what a carrying swivel overhead should be for Photographic Lamps.

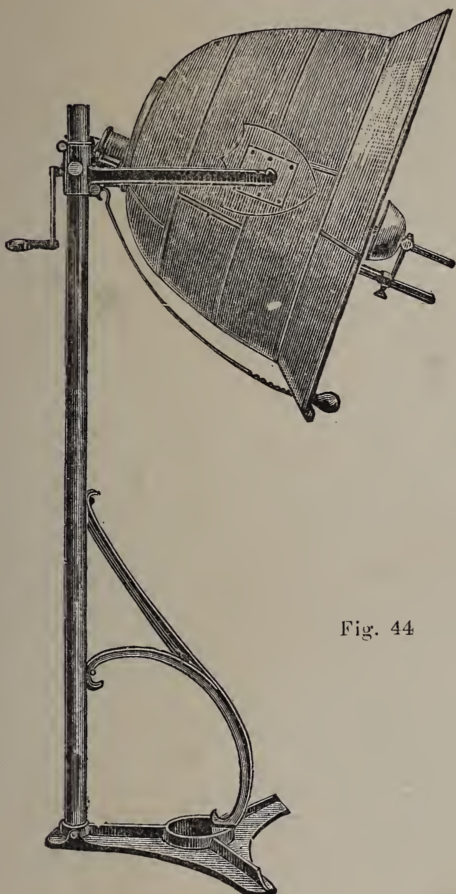


Fig. 44

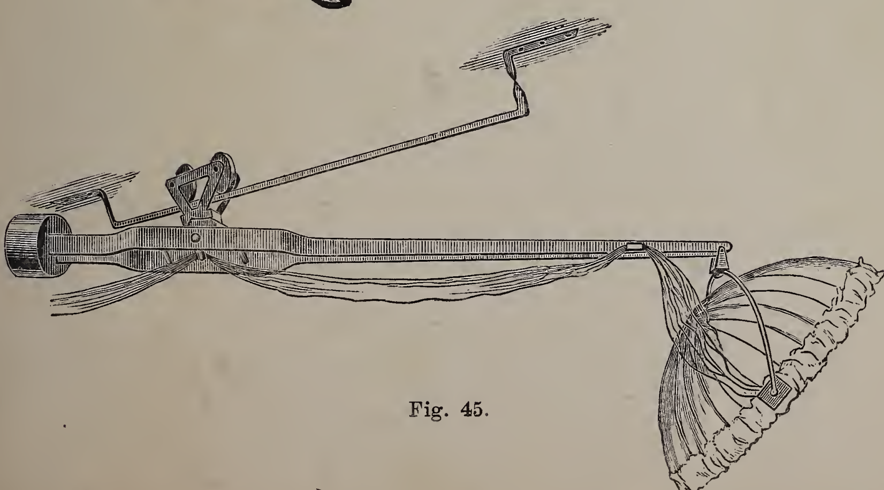


Fig. 45.

Fig. 46 is a sectional view of the lamp reflector, and shows the lamps on the outer circle.

The lamps are connected through an elaborate switching-box by numerous wires for the purpose of varying the power of the lights.

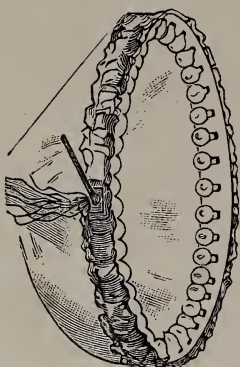


Fig. 46.

The author has seen excellent photos taken by this apparatus, but as to its working he has no experience, and therefore cannot give any further particulars about it.

Another design by the author for a portraiture apparatus employs Jablochkoff candles. Five of these can be used on a 200 volt circuit or on a transformer.

The five candles are stood in a row on a slate or stoneware strip, as in Fig. 47. A bent tube suspends the whole apparatus, and the reflector is in this case simply a flat, square sheet of smooth zinc, brass or steel, whitewashed.

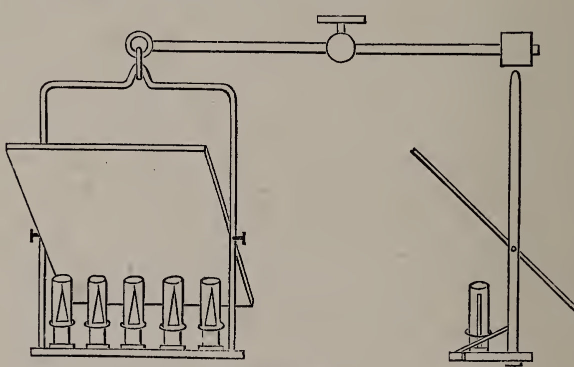


Fig. 47.

A screen, in front of the candles, keeps off the direct light.

This is a simple and excellent apparatus with alternating currents; it will work perfectly and give a very powerful light. In fact, by making the reflector about 6 feet × 3 feet 6 inches, a large group, such as would fill a theatre stage, may be taken at once.

With continuous currents it requires to be worked intermittently, for the current has to be reversed every five minutes;

but that is no great drawback, as an exposure only occupies a few seconds.

The same apparatus, Fig. 55, is designed by the author for photography by means of incandescent gas lamps, commonly known as Welsbach burners.

We may consider another design by the author for an Automatic Photo-Electric Lamp. It is another form of clutch lamp, Fig. 48.

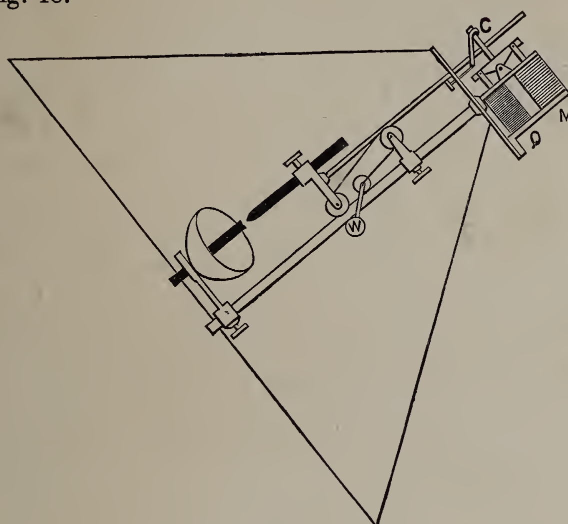


Fig. 48.

C is a clutch of which a large size diagram is shown in Fig. 49. By the tilting up of the clutch, when the coil, M, is

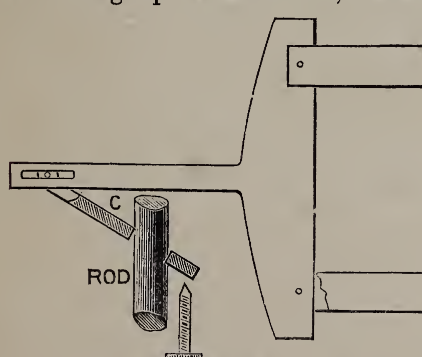


Fig. 49.

energized by the current, the carbon-holder rod is gripped and lifted up to form the arc. When the arc burns wide, the coil Q,

a shunt coil, pulls the lever down and so releases the clutch to allow the rod to slide through and thus maintain the arc.

Arc-lamp makers will see readily that almost any of the well-known arc-lamp mechanisms will feed a Photo-Electric Lamp, provided always that there is no gravity action in the feed. If there is any gravity action required, it may be on the moving carbon-holder, but never in the feeding mechanism of the lamp.

For instance, in Fig. 41 we have a core (C) in the mechanism, which acts by gravity. This is a drawback to that mechanism, for it requires the lamp to be used always at the same angle, so that gravity may always be the same. This is not of much consequence, however, for there is only one angle at which the best portraiture work can be effected—an angle of about 45.

In the mechanism of Fig. 48 only the upper carbon-holder is affected by gravity, and that is compensated by a sliding weight (W) working over a pulley by a cord.

Another point in this mechanism is the use of a spring instead of the shunt coil. A spiral spring does equally well, and renders the lamp cheaper and more suitable for alternating currents.

In some arc-lamps two pairs of carbons are burned simultaneously, and by that means the same light is obtained with half the current used; thus, two 25 ampère arcs are equal to one 50 ampère arc, and as the same pressure is supplied to work the two 25 ampère arcs as that supplied for the one 50 ampère arc, the electricity consumed in one case is $25 \times 110 = 2{,}750$ Watts; in the other is $50 \times 110 = 5{,}500$ Watts —just double.

Double lamps will not work well on 100 volts pressure. They require over 105, and work best at 110 volts. The reason is that considerable resistance is always required in a lamp circuit to enable the lamp to feed, and if sufficient resistance is put in to steady the lamp feeding, it reduces the current too much; thus, on 100 volt circuit, two 45 volt arcs = 90 volts, leaving only 10 volts of a surplus, and 10 volts divided by 25 ampères $= \frac{10}{25} = 0{\cdot}4$ ohms, the resistance which could be used—a resistance too small for steady work; but with 110 volts we have a surplus of 30 volts, which, divided by $25 = \frac{30}{25} = 1{\cdot}2$ ohms resistance, which may be inserted, and this will be found to give a good result with two arcs in series of 25 ampères each.

Double arc lamps with hand-feeding work well, down to 100 volts. If the operator takes a little pains to learn the art of hand-feeding, it is easily acquired, and is a perfect feed if one

only takes the little necessary trouble. Any of the lamps described can be made double arcs by several devices; some devices for double arcs are, however, patented, and therefore cannot be supplied by every firm.

Gwynne and Co., as already stated, have a patented device for making their Pilsen lamp a double arc, and it answers well.

Fig. 50.

Fig. 50 A is another portraiture-lamp by Borland, of Leeds. The lamp mechanism is that shown in Fig. 25, the *scissors* lamp. The reflector is four feet in diameter, and curved into a sort of parabolic form, called an umbrella reflector.

COPYING LAMPS.

Fig. 51 is the usual arrangement for copying. The lamp best for this purpose is that described in Figs. 19 and 20.

The picture to be copied is pinned against a board upright on a suspended pair of rails. The camera is carried on a sliding table on the same pair of rails, the lamp is hung to one side sufficient to clear the view of the camera, and the light is thrown on the picture obliquely. If the picture has a glazed surface, care is taken that the reflector from the surface, acting as a mirror, does not fall upon the camera lens. This can be avoided by adjusting the angle of incidence of the light from the lamp.

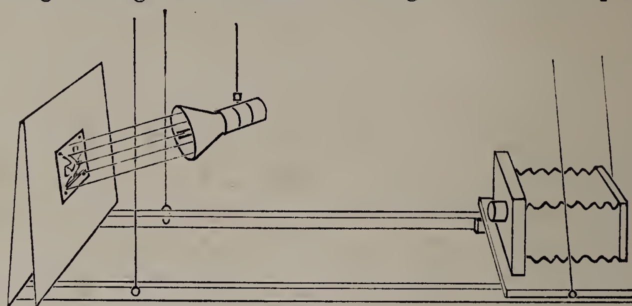


Fig. 51.

Two lamps may be used, or three—one on each side and one above—if the picture is large.

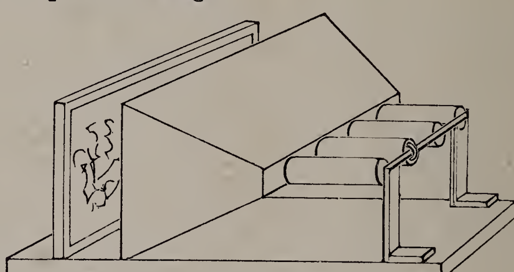


Fig. 52.

Fig. 52 is a diagram showing how the apparatus shown in Figs. 38 and 39 is used for printing from negatives or tracings.

It has four lamps in a reflector; in front stands the frame with the matter to be printed.

Four lamps of 15 ampères do this work well.

This apparatus costs £25—that is, the four lamps and the reflector, with a resistance and switch.

The horizontal lamps for copying are sold complete for £10 each, with proper conical reflector fitted.

As to the prices of complete sets of photo-electric plants, of course, different makers put different values on the same products,

and the price-lists are not always a safe guide to go by. As the author has considerable experience in the making of electrical machinery and apparatus, he ventures to estimate the fair price for photo-electric sets, including variable resistances with switch, an ammeter and suspension gear, reflectors, lamp, and all complete, to work up to 70 ampères at £25 nett. if automatic; double arc set same price. No difference, whether alternating or continuous. This price does not include any fixing, painting, packing, discount, carriage, wiring or starting up, or any extras whatever.

For a hand-fed set with reflectors, lamp, suspension gear, resistances, switch and ammeter, £15 nett, same terms as above.

These, of course, are the author's prices. Other designers may be able to make cheaper designs, and others again will be found to be dearer, but these figures may be taken as a fair average estimate, allowing for good workmanship and materials and good working designs.

For printing photographic negatives, a very effective apparatus, worked by the author, is shown in Fig. 53. A 50-ampère

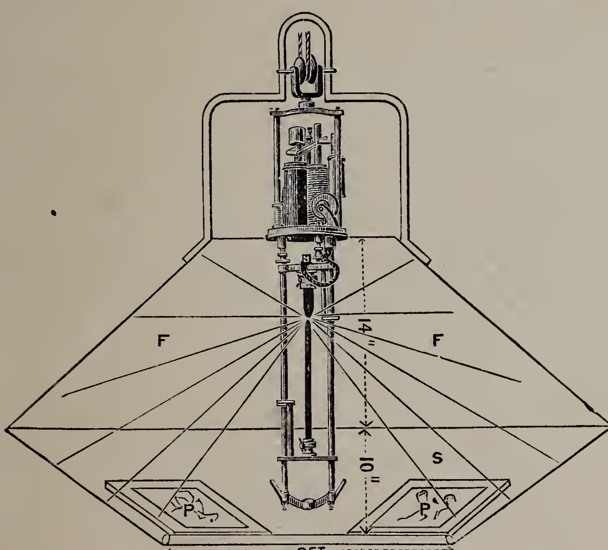


Fig. 53 A.

arc-lamp is required, preferably a focussing lamp, as shown. This is hung in a large, conical reflector, F F, with a dead-white surface, and to this is fixed an inverted conical reflector, S, upon which to lay the negatives, as shown at P P. The opening at the

top of the reflector should be 18 inches diameter, and the diameter at the widest part 4 feet. The opening at the bottom should be 2 feet diameter.

With this apparatus, prints may be made in ten to twenty minutes of fairly dense negatives.

The apparatus is suspended by a hook, as shown. The reflector is shown in section ; it is circular in shape, and made of tinned iron.

With all these apparatus for providing him with effective artificial light for his work in every line of business, the photographer is now independent of seasons and weathers. Hitherto the plant has been too expensive for general adoption ; but it will be gathered, from this brief description of the various apparatus, that cheap and effective lamps and appliances are or will be available.

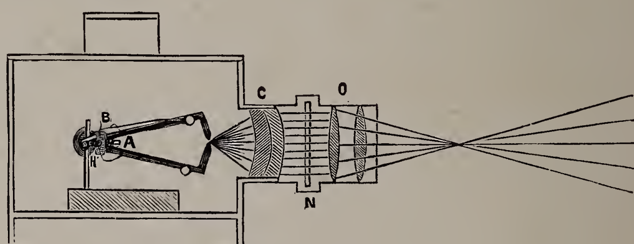


Fig. 54.

For optical work, or for enlarging photographs, the arrangement shown in Fig. 54 may be used. The lamp shown is the "Scissors" lamp of Borland, Leeds, but another form may be used if desired. It is essential that the arc be fixed in the focus of a condensing lens, C, to make the rays parallel in passing through the picture. An ordinary magic lantern condenser is first-rate for this purpose.

The figure shows the general arrangement. The front is simply a magic lantern front, with photo object-lenses, and a large condenser, 5 or 6 inches diameter. The current required is 10 to 15 ampères.

GAS PHOTO APPARATUS.

Every photographer is within reach of a gas supply, so that this apparatus is available where no electric supply is to be had.

The author's apparatus consists of a white-washed reflector of sheet zinc, hung in a frame of ½-inch iron piping or ½-inch

rod iron. The reflector may be made large, but the smallest size of any use is 3 feet 6 inches square. For this size 10 burners may be used, each placed as close to the other as they can be fixed. A 4 ft. 6 in. reflector should have 16 burners.

It is not necessary to screen off the direct light of the burners except very slightly, by either having the tubes ground on one side or painted with alum water, or otherwise rendered semi-opaque.

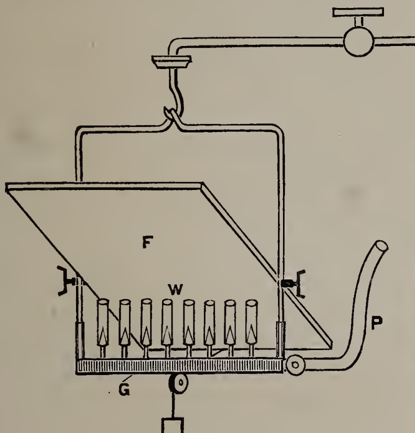


Fig. 55.

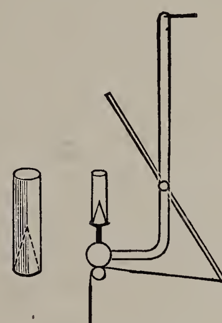


Fig. 56.

Fig. 55 is a complete view of Kennedy's Gas Photo-Electric Apparatus; W are the burners, F the reflector, and P a rubber pipe to supply the gas.

Fig. 56 shows a tube for the burners half obscured on one side.

The gas-light apparatus is cheap and handy, and can be applied anywhere, and really makes beautiful work. The only drawback is the heat and foul gases it gives off, but these can be easily got rid of by a ventilator in the roof of a studio.

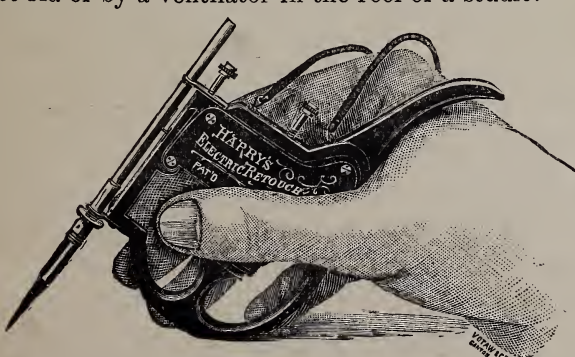


Fig. 57.

ELECTRIC RE-TOUCHING.

Fig. 57 is an electric re-touching device, in which the pencil is vibrated by a contact-breaker, the same as is used in induction coils. It is driven by a pair of galvanic cells.

OPERATING THE RE-TOUCHING DEVICE.

Attach the copper tips on the conducting cord to the brass binding-posts of the battery. The two smaller tips attach to the re-touching device.

Use whatever grade of leads that will best suit your touch.

To make a light stroke, turn the top adjusting screw to the right.

To make a heavy stroke, turn it to the left.

The other adjusting screw must be left as it is.

Occasionally give the small wheel near the pencil-point a quarter turn. The pencil-point wears off at an angle, and this will give a new cutting edge. In this way you can re-touch for hours without removing the pencil.

For blending, move the device lightly and rapidly.

There is no style of work you cannot do with this re-touching device.

The length of the pencil-point is very important to do fine work, and must extend from $1\frac{1}{4}$ to $1\frac{1}{2}$ inches in length from the pencil-holder.

RANKIN KENNEDY'S PHOTOGRAPHERS' ELECTRIC PENCIL.

Figure 58.

This pencil is used by photographers for dodging or re-touching photographic negatives.

In re-touching the defective lines or spots on a negative, the

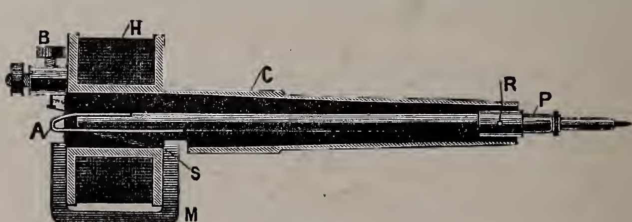


Fig 58.

stroke of the pencil requires in many cases, in fact, in almost every case, to be minutely small, and therefore to obtain the desired effect is a very slow process, as these small strokes have to be made with great care.

Recently, an American firm introduced a pencil which is rapidly revolved by a small electromotor, so that the point of the pencil spins, and thereby is rubbed on to any spot by simply moving the point gently over it in any desired direction, thus doing away with the necessity for the tiresome confined motion of the operator's hand.

Another method and apparatus also recently introduced from Germany consists in fixing the negative in a frame which is vibrated rapidly by an electro-magnetic apparatus.

The appliance herein illustrated is a British production, and in it the pencil-point is very rapidly vibrated through an exceedingly small stroke by a simple electro-magnetic contact-breaker, so that the pencil has only to be guided by the operator while the electro-magnet performs the necessary rubbing at an exceedingly rapid rate—about 200 strokes per minute.

It is claimed that this form is simpler and less liable to derangement than the rotating form.

A battery of two large Leclanché cells work this vibratory pencil, and where a number are in use one contact-breaker can be arranged to work them all. Referring to the figure, P is the pencil pivoted at R in trunnions, C is an ebonite case carrying a bobbin of fine wire, H, B is the contact-breaker platinum screw point, A is the armature—a light piece of soft iron passing through the coil, M is a piece of soft iron fixed outside of the coil to which the armature is attracted. A spring, S, opposes the attraction, and sends back the armature, which is fixed on the end of the pencil. It will be readily seen that the pencil-point makes a small motion compared with the play of the armature.

ON THE ARC AND CARBONS.

Carbons for arc-lamps should be of proper size to suit the current, and the positive carbon should be fixed to top or bottom holder according to the use for which the lamp is used. For copying, printing and other purposes with a horizontal lamp the inner carbon should be the positive, that is the one on the moving rod;

with the upright lamps, the upper carbon should be the positive for lantern work or for printing and copying.

With the Photo-Electric Lamp the positive carbon should be the fixed one in the small bowl in every case.

Alternating current lamps have no positive or negative; both carbons burn alike, and should therefore be of the same size, and both should be cored carbons.

Hard carbons last longer but give less light than soft ones.

When an arc hisses the arc is too short, when it flames it is too long, and flaming occurs also with too thin carbons; sputtering is due to bad carbons.

Cored carbons must be used with continuous current lamps for the positive carbon. Good cored carbons are easily got, and so are bad ones; the worst fault in cored carbons is want of continuity in the core. The only guarantee of good carbon is to have it from well-known makers such as Conradty, Siemens', Lacombe, or Carré. The following is a list of carbons giving the proper sizes for different continuous currents. For alternating the sizes should be the same for both, and both cored. The column for the negative carbons will give the sizes for the alternating lamps:—

Current in Ampères.	Positive Cored Diameter.	Negative Solid Diameter.
	m/m	m/m
5 and 6	9	9
8	11	9
10	13	11
15	15	13
20	18	15
30	20	18
50	25	20
80	30	25
100	35	30
140	42	35
170	50	42
200	60	50

These sizes will give the best efficiency, but for the best light a pair of carbons 10 per cent. less in diameter may be used.

Without a special adjustment, which no lamp in the market has attached to it, a lamp made for 25 or 50 ampères will not burn well at any other current strength, unless it is a hand-fed lamp, and even then the carbons must be made proportional.

If a lamp hisses, when supplied with the proper current, it indicates something wrong with the thick wire coil ; if it flames with the proper current, it indicates something wrong with the shunt coil—always presuming that the lamp mechanism is right.

A lamp which feeds by jumps and jerks, occasionally silent, and then hissing, is radically out of adjustment, and requires the attention of an arc-lamp expert to decide on its treatment, or the maker of it must be called upon to set matters right.

If photographers would go to the slight expense of calling in the advice of an electrician when contracting for a photo-electric plant, much trouble would often be averted, as then the plant would be tested and accepted only when correct.

In working the arc-lamps for photo purposes, it must be borne in mind that mere brightness of light is no criterion of its photographic power. The photographic rays are not the bright light rays in the spectrum. It is a great mistake to put greater than 50 ampères in an arc for photo-portraiture purposes. If a large group is to be illuminated, two apparatuses, side by side, should be used, each of 50 ampères.

A long arc, although giving less light than a short arc, is far more powerful photographically ; so that a long arc, even although slightly flaming, is the best for the purpose. A short arc can be discovered by measuring the volts across the arc ; if they are under 42 or 43 it is short, if over 46 it is generally long and may be as much as 50 volts. But different carbons alter these figures somewhat, but not much.

As a general rule, the vertical inverted lamps, working as in Fig. 15, are cheapest, and give less trouble than lamps working at different angles. The lamps shown in Figs. 13 and 15 will work at different angles, and for working on the separate lamp and reflector system are perfect at the slight angles required in that system.

It will be gathered, from this brief description of the various lamps and methods, that the photographer has the choice of a good variety. The umbrella reflector and diagonally-hung lamp has served its purpose fairly well, but at best it is a clumsy and unwieldy arrangement.

The author's experience points to the separate lamp and screen system, or the inverted lamp with the diagonal flat reflector, as the apparatus which, in the end, will be found much preferable for Photo Portraiture work.

The General Electric Company's Photo Lamp is a hand-fed arrangement on a stand. The complete plant is priced £26.

The Lamp, Fig. 59, is arranged so that it can be directed at will by the operator, so as to give either a top, side, or bottom light. It is constructed so that the sitter cannot get direct rays, but only reflected light.

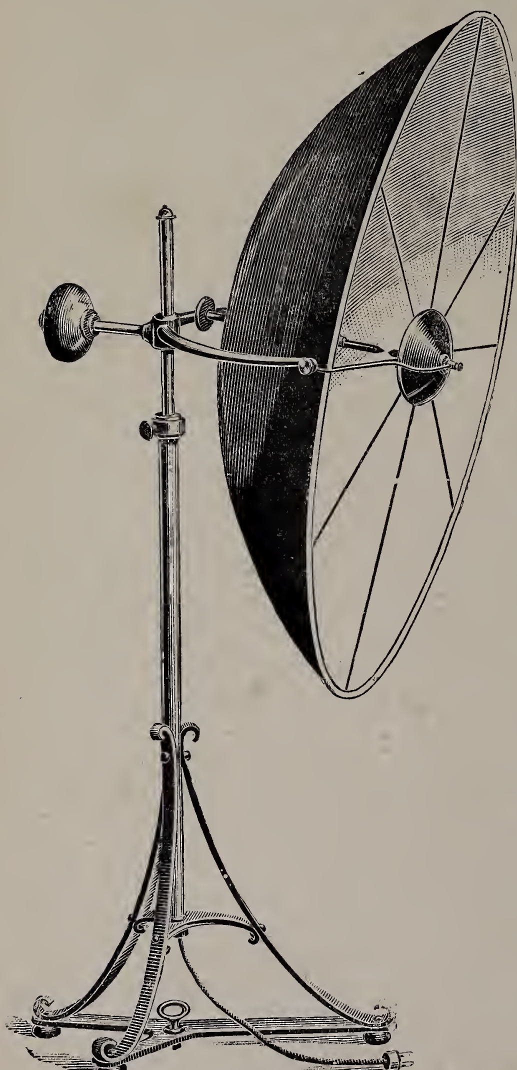


Fig. 59.

The Reflector is 4 ft. 6 in. diameter, and made of a light material, and nicely balanced in the stand. Internally it is of a dead white, so that it gives out a soft diffused light. The stand is adjustable, so that it can be raised or lowered to any desired height.

The Light given is 10,000 candle power nominal, or, if desired, can be varied either more or less to suit requirements.

The shape of the reflector is correct in this illustration, and generally it is a useful plant.

It is a remarkable fact that most of the public supplies of continuous electric current are remarkably sensitive, and this extraordinary weakness is guarded against by Central

Station Managers making strict rules regarding the use of resistances in the circuit of large arc lamps for gradually turning on the current.

Intending users of large arc lamps should therefore inquire carefully as to these rules before arranging for them, for it is not uncommonly the case that it would be cheaper to use a storage battery, or to have an independent gas engine and dynamo, than to comply with the said rules, which are not only absurd in most cases but quite prohibitive of the use of arc lamps by photographers.

A day supply can in most places be got cheap—say, about half the cost of the night supply of electricity.

Photographers ought to avail themselves of this fact by storing their supply during the day load hours at the central station.

By this means they not only get their electricity cheaper, but also evade the stupid rules made by the managers to preserve their sensitive balance. These remarks apply to continuous current circuits.

On alternating current circuits there is no bother about supplying large arcs.

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